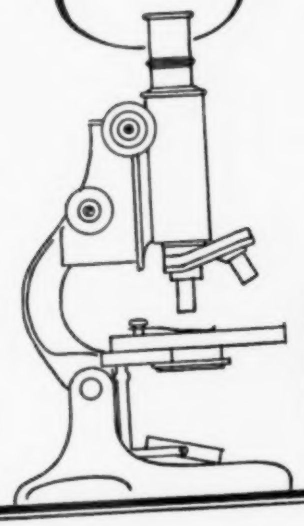

The SCIENCE COUNSELOR

A Quarterly Journal for
Teachers of Science in
the Catholic High Schools

VOLUME III
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MARCH, 1937

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The Science Counselor

"FOR BETTER SCIENCE TEACHING"

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Volume III MARCH, 1937 No. 1

CONTENTS

Science Essay Contest . . .

The decision of the nine faculty members chosen to read the essays submitted in the 1937 Duquesne University national science essay contest for students in Catholic high schools, was announced at the Conference for Teachers of Science which was held at the University on February 20. The successful students and schools are listed below.

To the winner of the first prize a gold medal has been awarded; to her school for one year possession, a silver cup, suitably engraved. In addition to the first honor, five honorable mentions, all of equal value, were announced by the committee of judges. We congratulate the winning students. Every pupil who entered the contest benefited by his participation. We know that the families, teachers, and friends of the successful participants will rejoice in the honor that has come to them.

The winning essay will be published in the June issue of the SCIENCE COUNSELOR.

The winner of the gold medal is CATHERINE MARY MELANSON, of St. Charles High School, Waltham, Mass. Her essay was supervised by Sister Annisa of the Sisters of St. Joseph.

Honorable mention is given to each of the following:

Florence E. Thein, Bishop McDonnell Memorial High School, Brooklyn, N. Y. Supervisor: Sister Bernadette de Lourdes of the Dominican Order.

Mary Helen McCann, of Mercy High School, Chicago, Ill. Supervisor: Sister Mary Evelyn of the Sisters of Mercy.

Frances Marie Gage, of St. John's High School, Fresno, California. Supervisor: Sister M. Scholastica, of the Sisters of Holy Cross.

Dorothy Elizabeth Kearns, of Bishop Toolen High School, Mobile, Alabama. Supervisor: Sister Mary Naomi of the Sisters of Loretto.

Marie Schoepflin, of St. Francis Academy, Mt. Providence, Pittsburgh. Supervisor: Sister M. Loyla of the Order of St. Francis.

Elementary Science In Education

● **By W. W. Knox**
STATE SUPERVISOR OF SCIENCE, ALBANY, N. Y.

Can science make special contributions to the serious work of preparing children for intelligent citizenship in our modern world? Dr. Knox believes that it can, but he feels that a continuous experience in the field is necessary if a well-rounded intellectual growth is to be achieved.

Here he discusses the objectives of science instruction and outlines the beginning of a 12-year program covering the elementary and high school fields. The proposed plan is workable, for it is based upon the experiences and reactions of thousands of teachers and supervisors of science in the schools of New York State.

This is an important article.

●

PHILOSOPHY OF EDUCATION

The human race has been struggling through many thousands and hundreds of thousands of years to understand and in a measure to control factors in its environment. In prehistoric days man's curiosity was limited only by his meager knowledge. Mental adjustments to the happenings and changes that went on about him were extremely difficult. Cause and effect relationships were not recognized and in his ignorance man attributed events in his life, even everyday occurrences such as the weather, the movement of the stars, fire, and light, to mysterious and supernatural causes.

The education of the young in this period was a relatively simple matter. The fund of knowledge to be passed on to the children of the cave-man, for example, was exceedingly limited, both with respect to knowledge of the environment and with respect to rules of conduct used in dealing with fellow human beings. The accumulation of knowledge in both of these fields, the pure sciences and the social sciences, progressed slowly during many thousands of years.

During the last four or five hundred years, and particularly during the last hundred years, however, progress in these fields has been increasing at an accelerated pace. Ten thousand years ago it might have been possible for a thoughtful man to master all fields of knowledge as they were then known. Today, this is impossible. Knowledge has become so specialized that a man can spend his entire life profitably in mastering and extending knowledge within a very restricted area. It is evident, therefore, that the cultural inheritance of children born today is vastly different from that of children born ten thousand years ago. The biological inheritance, on the other hand, is identically the same. The child of today may be said to have the same physical and mental equipment as that possessed by children of the cave-man period.

Our attention is immediately focused on the enormous task that faces us in education—in preparing children for intelligent citizenship in our modern world. It is the business of the schools to help bridge this gap and guide the children through a long series of the most worthwhile experiences of the race in order that they may take advantage of the accumulation of the past and be in a position to make contributions of their own for the future. At this point the question might well be raised as to the contributions science may make toward this end.

THE CONTRIBUTION OF SCIENCE

With the exception of language which may be classified as a tool, man's knowledge can be classified in two broad divisions—the pure sciences and the social sciences. Basically, science is often described as a fund of knowledge and a method of thought. In the accumulation of this vast fund, methods of attacking problems were evolved. These methods are ways of acting and ways of thinking that have proved to be desirable in the solution of problems not only in the field of the pure sciences but in other fields as well. People who use these methods are frequently referred to as having a scientific attitude of mind.

It is well for us to remember that the facts or principles of science go hand in hand with the methods and in general cannot, or at least, should not be separated in our school programs. In recent years it has become quite popular to minimize the value of facts, and to stress attitudes and appreciations that are really the natural by-products that are produced in dealing with facts. In other words, attitudes and appreciations cannot be developed in a vacuum but must be centered or conditioned in factual knowledge. Both facts and the so-called scientific attitudes are inherent contributions that science has to offer in the general program of education.

These contributions of science, when made available to children, offer special values and outcomes that may be described as follows:

1—Health Knowledge

For the rationalization and strengthening of health habits there can be no more powerful influence than the simple fact made real to children in the science laboratory—that bacteria cause disease. The washing of hands and the necessity of maintaining a supply of pure water for the community are immediately justified.

2—Mental Satisfaction

The study of science offers many satisfactory mental adjustments to normal children who are full of curiosity and who wish to know the "whys and wherefores" of all that they see and hear. Without these satis-

Continued on Page Sixteen

Science Project Work

For High School Students

● By Joseph Singerman
JAMES MONROE HIGH SCHOOL, NEW YORK CITY

The writer of this article confesses that as far back as he can remember he has always been a tinkerer. There could be no better recommendation for a teacher who would interest students in the construction of science projects.

A wealth of experience in directing work with pupils of high school age enables Professor Singerman to write a practical and helpful paper.

The careful pointing out of pitfalls is of especial value to the teacher who is new at the work.

●

Science project activity among high school students frequently reaches a high level of achievement as a phase in the functioning of the science club. The science club is an accepted adjunct to every high school science department. Herein the boy or girl with an interest in science finds excellent opportunities for self-expression and personal development. The writer has had considerable experience in the supervision of construction projects, and this article relates more particularly to that phase of science project work.

Construction projects, properly supervised, offer one of the finest means of furthering certain desirable educational aims. This was discussed in the writer's article in *High Points* for April, 1935. Such aims are:

1. Development of *initiative*.
2. Stimulation of appreciation of and interest in *environment*.
3. Preparation for *leisure* time.
4. Development of scientific *attitudes*.
5. Acquisition of understanding of science *facts* and *principles*.
6. Development of special *skills*.
7. Development of skill and interest in the use of *library* references.
8. Inculcation of desirable *habits*.
9. *Appreciation* of accomplishments made by others.
10. Realization of the spirit of *co-operation*.
11. Encouragement of *sociability*.
12. Development of a spirit of *optimism*.
13. Promotion of ability to make *contacts*.
14. Encouragement of a feeling of *self-respect*.

The extent to which each of these aims may be accomplished is limited by the qualifications of the sponsor, the type of pupils, the kind of equipment, the amount of funds available, and by special school or board of education regulations. It is highly desirable that the sponsor shall be one who possesses a high degree of patience and a keen understanding of the emotional makeup and psychology of the youngsters whom he wishes to guide. The type of construction projects upon which the club embarks is frequently influenced by the past experience of the sponsor. The sponsor's special interests and abilities play an important part in determining both the kind of projects and the manner of carrying them out. In one instance, a sponsor had devoted some time, in post-graduate courses, to the study of ferns. Through her enthusiasm and interest, the boys and girls did some outstanding work in collecting and studying many varieties of ferns. Another sponsor was mechanically minded, and he was ingenious in making suggestions. His club constructed a gas engine out of tin cans and scrap metals. A third sponsor had had some experience in the use of many tools. Youngsters under his supervision were busy at one time with the construction of a working model of a steam engine.

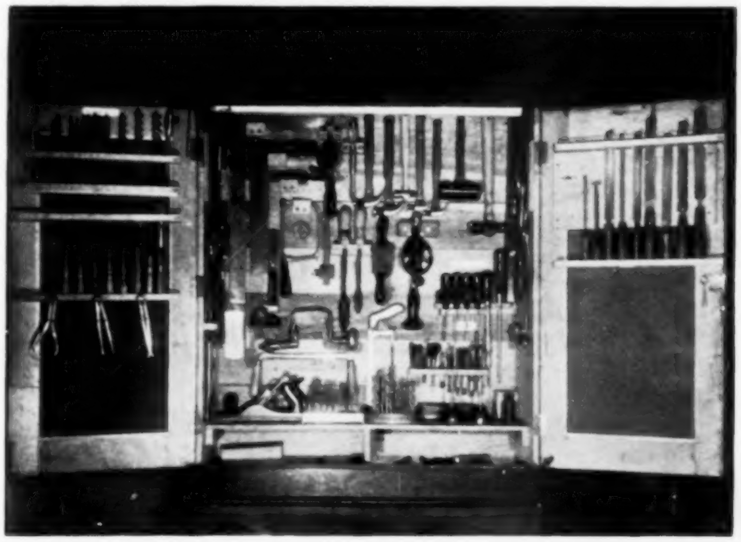
It is obvious that a project handled successfully by one sponsor may prove to be a failure in the hands of another. Boys and girls will, as a general rule, attain the highest degree of success when they are developing projects which relate to the field of the sponsor's experience and interest.

The extent of activity, and the degree of success, may be greatly enhanced by the collaboration of two or more sponsors. Construction projects usually require considerable of the sponsor's time. The amount of time that he can devote to supervision must be considered in deciding on the type of projects to be undertaken. The teacher who gives thorough attention to his curricular work, and, at the same time, carries on a wholesome social, recreational and intellectual program of personal activity, should, it seems to me, make a good club sponsor. Unfortunately, such an individual cannot find much time to give to club work without either lowering the efficiency of his regular professional duties, or infringing on the time needed for worth-while personal activities. This, too, speaks for the desirability of sponsor collaboration.

In making a choice of projects, consideration must be given to the individual pupils concerned. Young boys and girls will, almost invariably, select ambitious projects without any real comprehension of the difficulties involved. The sponsor should consider such proposals in the light, not only of the pupil's special interests, but also of his maturity, past education, experience, and personality traits. It is well said that there is nothing that succeeds like success. The sponsor should aim to avoid discouragement. Pupils should be permitted to embark upon projects only if there is reasonable expectation of successful achievement. This does not mean that the path ought to be smoothly paved. On the contrary, the youngster should be permitted to meet obstacles; but these obstacles should be surmountable by the one concerned. Deliberately

throwing in his path obstacles which are insurmountable, considering the pupil's possibilities, is inexcusable. The youngster who lacks perseverance, thoroughness, and aggressiveness should not be permitted to embark upon a task which calls for those qualities to a high degree, unless there is good reason to expect satisfactory accomplishment. He will develop these desirable traits by experiencing success in their application.

Construction projects involve the use of materials, tools and machines. The availability of such equipment, and of funds for its maintenance and extension, are of prime importance. A radio cannot be assembled if solder is not available, or if the purchase of special parts is not possible. Certain tools are indispensable. Crudely constructed projects generally elicit an expression of admiration, but the sponsor should bear in mind the fact that the pupil is receiving good training when he learns to produce good workmanship, not workmanship that is "good enough." Good tools and adequate material will help to make satisfactory workmanship possible. Past experience in the handling of tools and material helps the individual in planning his work, since he knows that certain materials can be fashioned in certain ways. The writer has been a tinkerer with tools and materials since early childhood, and, even today, goes to his supply of metals when he has a design problem to solve, and, while handling bars and rods of various forms, visualizes their possible function in the contemplated apparatus. It is as though he actually thinks with the materials at hand. The junk pile frequently functions in this need.



THIS TOOL CHEST WAS USED BY STUDENTS IN THE SCIENCE PROJECT COURSE AT JAMES MONROE HIGH SCHOOL

It is of paramount importance that suitable raw materials be kept at hand. The following brief list is suggestive: Sheet metals; strip iron and brass; tubing, glass, copper, brass; machine screws and nuts; wood screws and nails; lumber; wire, various kinds; cement and glue; and ordinary laboratory equipment.

The "5-10-and-up" stores in large shopping centers display some good tools, but care must be exercised in their selection. The writer still has a few taps and dies purchased almost twenty years ago. It is well to direct the students' attention to displays in these stores. Tool catalogs, besides being suggestive, often contain valuable data. Leading tool manufacturers will send these free upon request.

Everyone knows that tools instinctively go astray, particularly when they are available to many individuals. The writer has had marked success in weaning tools from that habit. Our club constructed a tool cabinet in which there is a definite location or bracket for every tool. The rules of the club require that every student check up the whole cabinet before and after he uses any tool or tools in it. He signs the register, and indicates the date and the periods during which he worked. Every member of the club is proud of its reputation for care and honesty. The tool cabinet should be large, so that additional brackets can be added as more tools are required from time to time.

Where the age and maturity of the pupils justify their use, machines are an invaluable adjunct to a science laboratory. Due to large scale production, "home workshop" machines are available at reasonable cost. Some of these are of excellent design. The circular saw and jointer make a good combination. The drill press is very useful. The hand power drill press is worth having if the motor driven press is not obtainable, or if the students are too immature to handle it. A lathe will find many uses. It should be borne in mind that motor driven machines involve certain hazards. Belts, pulleys, cutters, etc., should be properly guarded. Close supervision of pupils using these machines is necessary.

The probability of successful completion of many projects is affected by the regulations of the school administration, or of the board of education. A requirement that the sponsor directly supervise each pupil at all times rules out many fine construction projects, except in some instances where much of the work can be carried out in a pupil's home under the supervision of his parents. Unfortunately, in the case of construction projects, that is not often possible. The sponsor cannot very well devote 120 hours or so, spread over many evenings, to supervise a group busy figuring a telescope reflector, in addition to supervising other types of work at other hours of the day. Special rules frequently bar the use of motor driven machines by

Continued on Page Twenty-nine

Contributions From a Junior Academy of Science

• By Professor Charles E. Mohr
READING, PENNA., SENIOR HIGH SCHOOL

• By Harry Gross
READING SENIOR HIGH SCHOOL

• By John F. Lingenfelter
ALTOONA, PENNA., SENIOR HIGH SCHOOL

The Pennsylvania Junior Academy of Science was instituted in 1934. Each year it meets concurrently with the Pennsylvania Academy of Science. The junior Academy is a group of affiliated senior and junior high school science clubs organized for the mutual benefit of its members and to give them an opportunity to meet leaders in science in the various fields. At their annual meetings the members read original papers, give talks, and perform experiments before other high school students. The papers here printed illustrate what is being accomplished in two Pennsylvania high schools. The papers have not been edited.

Professor Mohr makes a brief comment. The photographs which illustrate Mr. Gross's article were taken by Professor Mohr. They were used as slides by Mr. Gross in presenting his paper at the last annual meeting of the Junior Academy. Mr. Lingenfelter is a member of the Academy of Science of the Senior High School at Altoona. He says: "This paper deals with one of the most interesting families of fishes that I have had occasion to study."

The Pennsylvania Junior Academy of Science

Professor Charles E. Mohr
FACULTY ADVISOR, BAIRD NATURAL HISTORY CLUB
READING SENIOR HIGH SCHOOL

The first-hand knowledge of beetles shown in Harry Gross' article was gained through several years of intensive collecting and study while a member of the Baird Natural History Club. Accordingly, it may scarcely be said to represent a typical paper written by a high school science club member. It is, however, representative of the score of papers judged to be among the best presented during the year by individual members of the various science clubs which belong to the Pennsylvania Junior Academy of Science.

On that basis it was selected for the program at the annual meeting of the Junior Academy which was held last year at State Teachers College, Indiana, Pa. This practice has had a stimulating effect on our six science clubs here at Reading, and I know that other member-clubs also have been encouraged to develop a high standard of experimental and research work on the secondary school level.

Junior academies exist in a number of states beside Pennsylvania, notably Indiana and Illinois, and have the support not only of the various state academies but of the American Association for the Advancement of Science as well.

In Pennsylvania the development of a lecture service for member-clubs by members of the senior academy,

THE ANTENNAE OF THE LONG-HORNED BEETLES MAKE IDENTIFICATION EASY

and the distribution of a periodic bulletin of interest to member-clubs is now being planned. The additional privilege of attending the enjoyable and stimlating two-day annual session makes club membership highly beneficial.

The dues are one dollar per club per year, a sum within the reach of every science club.

Beetles I Have Collected

Harry Gross

PAST-PRESIDENT, BAIRD NATURAL HISTORY CLUB, READING SENIOR HIGH SCHOOL, AND PENNSYLVANIA JUNIOR ACADEMY OF SCIENCE

The order of insects predominant in the world, is the beetles. The order consists of about 150,000 known species which are grouped into approximately 80 families.

The members of this order can be readily distinguished from all other insects, except earwigs, by the possession of horny, veinless wing-covers called elytra, which meet in a straight line down the back, and beneath which there is a single pair of membranous wings; they differ from earwigs in lacking the pincer-like appendages at the end of the abdomen. Beetles differ also from earwigs in having a complete metamorphosis, that is, they go through three distinct stages, the larva, pupa, and adult; finally, the mouth parts are adapted for chewing.

The name of the order, Coleoptera, is derived from two Greek words *coleo*, meaning a sheath, and *pteron*, wing. It refers to the sheath-like structure of the elytra, or wing covers, which were originally believed to be modified wings.

To me, one of the most interesting families of beetles is the *Cerambycidae*, commonly called long-horned beetles. They get their common name from their long antennae, which are rarely shorter than the body and usually are more than twice its length. A familiar example of this family is the elderberry beetle. These long-horned beetles are usually found in early summer, as soon as the blossoms of most berry bushes are in bloom. As the blossoms of the berry bushes develop into fruit the beetles seem to disappear, but it is known that they first lay eggs in the stems of their food plant and then fly away to hide beneath the bark of various fruit trees.

Upon turning over a stone or log, one frequently sees small, flat, black beetles scurrying away. They belong to the family of ground-beetles, the *Carabidae*. The outstanding characteristic of these beetles is their long legs, which fit them for chasing rapidly over the ground in pursuit of small insects, though some of the larger species ascend trees in search of caterpillars.

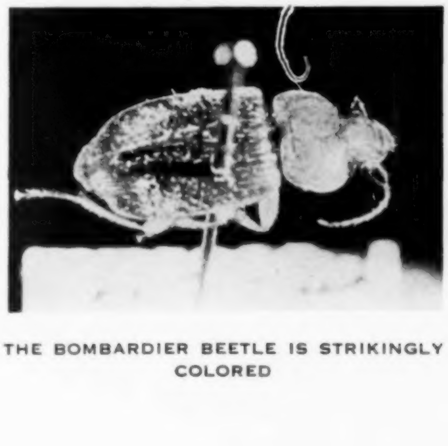
The celebrated bombardier beetle belongs to this family. This small beetle occurs plentifully in limestone regions, and is approximately a quarter of an inch long. The bombardier beetle is beautifully colored, having brilliant blue wing covers, and a striking orange thorax and head. When this small beetle is pursued by some larger insect it gives off a tiny stream of bluish vapor, explosively. This vapor has a very pungent odor, sufficient to halt the attack of the larger ground beetle long enough for the bombardier beetle to hurry away to safety.

We now come to the carrion beetles, the chief natural agents for the sanitary disposal of carrion. Wherever a dead animal has been left exposed, the carrion beetles may be found feeding upon it. The more common members of this genus, *Silpha*, are of a broad, oval shape, much flattened, with small heads. The commonest is *Silpha americana*. The flat thorax and abdomen enable the beetle to move freely beneath a dead animal.

The burying beetles are much larger, from an inch to an inch and a half long, with long stout bodies and large heads. The common burying beetle, *Necrophorus*, is shiny black with dull red spots. It derives its name from its habit of excavating beneath the dead animal, gradually burying it beneath the surface and there laying its eggs. The distended abdomen is well adapted for digging. The larvae feed upon the carrion.

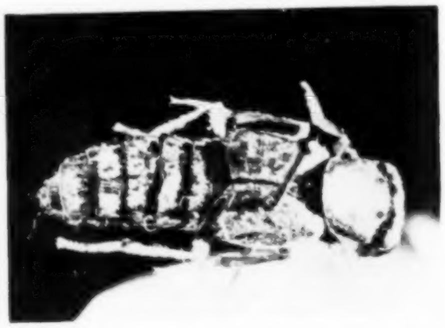
The rove beetles or *Staphylinidae* are readily recognized by the very short elytra, which rarely exceed one-third the length of the abdomen. Most species are very small, the larger ones being from one-half to one inch long. They run about swiftly and when disturbed raise the end of the abdomen as if to sting, an attitude resembling that of the scorpion.

The *Scarabidae* are one of the largest and most important families of beetles, numbering over 500 species in this country alone. They are thick-bodied beetles of the May beetle, or June beetle type, strong but very



THE BOMBARDIER BEETLE IS STRIKINGLY COLORED

clumsy. They may be divided into two main groups, the scavengers and the leaf-chafers. Of the scavengers, the tumble "bugs" are well known, as they are often seen rolling balls of manure along the roadside. They eventually bury these and lay their eggs in them. Sometimes the balls of manure are quite large



THE ROVE BEETLE IMITATES THE SCORPION, RAISING THE END OF ITS ABDOMEN AS IF TO STING

and I have seen two and even three dung beetles rolling the ball along until they reached a satisfactory spot in which to bury it. The fat grub feeds within this ball until it is ready to pupate.

Many of you have read or heard of the sacred scarabs of Egypt. Edgar Allan Poe used the scarabid beetle in his story "The Gold Bug." This beetle was held in veneration by the ancient Egyptians, who placed it in the tombs of the pharaohs and carved it on valuable stones and gems.

While the scavengers may be considered as somewhat beneficial, the leaf-chafers include many of our worst pests. The June "bugs" and May beetles, are among the best known representatives of the group, though there are about sixty species belonging to this genus. The larvae are typical white grubs which attach to the roots of grass, corn, and garden crops. These beetles feed at night on various shade and fruit trees, ragging the foliage as if it had been torn.

The Japanese beetle and the rose chafer are well known species, the Japanese beetle destroying roots of plants, and plant foliage; and the rose chafer, the flowers and leaves of the rose bush. The Japanese beetle is a newly imported scarabid, which about 15 years ago gained a foothold on the Jersey side of the Delaware River above Philadelphia. Japanese beetles are able to destroy a tremendous amount of foliage within a few days. When they settle in clouds, as they often do overnight, they can destroy an orchard or a large lawn.

Another type of scarabid is the flower beetle, so-called for its habit of feeding on pollen and nectar, which it carries from flower to flower and in this way causes cross-pollination. A common species of the genus is the yellowish-brown bumble flower beetle. It is one-half an inch long, quite hairy, and flies from flower to flower making a loud buzzing sound, like that of a bumble bee. Occasionally these beetles gather on ripening peaches or other soft fruits, or on the sap oozing from an injured tree. The larvae are white grubs which live in grass lands, and often injure the trees.

The most ferocious of beetles are the tiger-beetles. They are found along sandy paths, roadsides, railroad embankments, and in similar open sunny spots, flying up suddenly and darting ahead as one approaches.

The tiger beetles are fast runners and quick flyers and in the larval stage they certainly live up to their name, being cannibalistic, and have big heads and sturdy jaws. They usually dig funnel-shaped depressions in the ground, and lie in wait at the bottom for any unfortunate insect that chances to pass that way. Most of our common species are either a brilliant, metallic green, or gray banded with yellow. The fierceness of these beetles makes the name "tiger beetle" fitting, but unfortunately, from man's point of view, they are of little benefit as they do not frequent cultivated fields, and though they destroy many insects, but few of these are of any economic importance. The brilliant green species is my favorite, and one must be something of an acrobat and a sportsman to secure any number of them.

The predacious diving-beetles are to be seen in almost any pond where they appear to be suspended at the surface of the water with the tip of the abdomen thrust into the air. This is done so that air may be drawn under the elytra. These beetles dive after their prey, which consists of any insect which they can overpower, and even small aquatic animals, and occasionally small fish.

The largest diving beetles are about an inch long and are brownish black, usually edged with dull yellow. The hind legs are long, flattened, and fringed with hairs, forming perfect swimming organs. They get their name "water tiger" from the persistent manner in which the larvae search for living food.

The families of beetles reviewed in this report are the ones most commonly found in Pennsylvania, and in adjacent states.

The collecting of beetles is fairly easy, but some difficulty arises in pinning, identifying, classifying, and

THE CARRION BEETLE IS FLAT, ENABLING IT TO MOVE FREELY BENEATH A DEAD ANIMAL

labeling them. Most beetles are collected during the warm months. Specimens collected are placed in packets to be disposed of during the winter.

The necessary equipment can be easily obtained, and at little expense. The most essential, other than a pair of sharp eyes, are a cyanide or killing jar, and a pair of tweezers, while a butterfly net frequently proves useful.

During the winter months one relaxes the beetles in a moist jar, and places an insect pin through the right elytron about two-thirds of the way up on the pin. A label is placed on the pin stating when and where the beetle was found. This is important and requires the keeping of careful notes. If you wish to exchange specimens, you place on the pin your own collector's label. The next step is to separate all beetles into their distinct families, and pin them in permanent insect boxes, to be put away for future reference and general research.

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Cichlids

John F. Lingenfelter
ACADEMY OF SCIENCE, SENIOR HIGH SCHOOL, ALTOONA, PENNA.
BOYS FEDERATION NATURE STUDY CLUB. EXPERIMENTAL, RESEARCH, AND ANALYSIS CHEMISTRY CLUB

There are few members of that large group of fishes known as exotic aquarium fishes (popularly called "tropical fishes") that are more desirable than the cichlids. These fishes by their beautiful coloring and unusual mating habits more than offset any objections made because of size or pugnacity. I would like here to call your attention to some of the unusual characteristics of these desirable fishes.

Did you ever hear of a fish which gave its babies a bath? If you did there is great probability that it was a species of cichlid. Perhaps it was the jewel fish (*hemichronis bimaculatus*), or the angel fish (*pterophylum scalaris*).

The first event in the breeding of these fishes is their mating. The experienced aquarist usually does this by separating a pair of these fishes with a glass partition. If the fishes are in breeding condition they will display stronger and brighter color. This is usually accompanied by flirtations on either side. At this time, if the partition is removed, the fishes will rush at each other and interlock lips. Some have described this interlocking of lips as a sort of kissing, but I think that it resembles the grip of two bulldogs rather than an incident of affection. This is, however, a crucial moment. If either breaks the grip, he or she will be pursued by the other and probably killed if not removed by the aquarist.

If, however, the fishes find in each other a satisfactory mate they will begin to clean places in the sand in anticipation of laying eggs. Often rocks are cleaned, or the side of the aquarium is given an immaculate scouring. Then upon one of the chosen spots the eggs are laid by the female and fertilized by the male. From this time on the eggs are guarded and fanned constantly by the parents.

When the eggs hatch, the babies are picked up in the mouths of the parents and placed in "cradles" or depressions made in the sand by the parents. They are constantly moved from one place to another, and all intruders, even the feeding hand of the aquarist, are viciously attacked by the parents.

All this moving about of the babies by the parents may seem somewhat useless and time wasting to the casual observer, but it has been shown that each baby upon being picked up by the parent is carefully rolled about inside the mouth of the parent, and thus a good cleaning is assured. New nests are constantly prepared so that the babies will receive cleaner, fresher surroundings. In this way dangerous bacteria which might infect the babies are disposed of.

There are occasions when the eggs, upon hatching, are greedily eaten by the parents. The reason for this is not well understood, but it has been observed that when the parents are frequently disturbed, this action is especially prevalent. Perhaps the parents decide that the world is too cruel and unsafe for their babies, whereupon they save them from future misery by eating them. Granting, however, that everything has been satisfactory, we find that the home life of these fishes is a picture of domestic bliss.

It is an interesting picture to watch the mother, leading the way, with the babies following in a cloud, and father, as usual bringing up the rear hurrying straylings and warding off interested and hungry neighbors who are waiting for a delicious morsel if father's vigilance ceases, which, fortunately, it seldom does.

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THE TIGER BEETLE IS MY FAVORITE

Laboratory Drawings in Biology

● By Morris L. Alpern, M.S. in Education, *(College of the City of New York)*
COLBY ACADEMY, BROOKLYN, N. Y.

A perennial question in biology—to draw, or not to draw.

Recently, Mr. Alpern conducted an investigation of the comparative effectiveness of student-made and prepared drawings. The results of his research are here given. In addition, he has made a careful study of the literature.

This article should help to solve a bothersome problem.

●

"How many dots shall we make to show protoplasm in the ameba?" "Where shall we begin in drawing a grass-hopper's legs?" "May we use a ruler?" These and similar questions asked by students indicate a shift in attention from the material under observation in the biology laboratory to the technique of drawing.

Of what value is laboratory drawing? The procedure of making laboratory drawings has been criticized as being a "pedagogical formalism." Moreover, it consumes a great deal of time, thus preventing and minimizing the opportunities for more important outcomes, such as the development of the scientific attitude and the realization of the significance of science in everyday life.

What sort of drawings are we requiring of our students, and what are the results? Laboratory drawings may roughly be classified into two groups, representative and analytical. A representative drawing is one "which reproduces as accurately as possible the exact appearance of an object." Analytical drawings are those in which "imitation is not the chief end, and include outline drawings and cross-sections." In 1929 Baird[1] published an extensive study of biology notebooks "representative of small, medium, and large secondary schools, both public and private, and geographically distributed throughout the state of New York." He found " . . . The emphasis is on the non-analytic phase, for 62 per cent of the plant drawings, 56 per cent of the lower animal and [illegible] per cent of the human physiology (drawings) . . . This study tends to show how eager children are to add the picture effect to the drawings . . . Accuracy and proportion are not a general characteristic of the drawings . . . There is no evidence that the drawings were made from actual specimens, and any drawing in any notebook may have been copied from a book . . . A study of the drawings indicates that probably too much of the student's time is devoted to drawing and possibly much of this time is spent in copy work . . . There is evidence of time wasted in trying to display artistic skill and in unnecessary coloring of the drawing."

Ballew[2] finds that many students encounter great difficulty in drawing whereas others with artistic ability have a distinct advantage. The ultimate object of the laboratory procedure becomes the making of artistic drawings which creates a strong tendency to copy drawings from the textbook or other students and the tracing of drawings from reference books.

In an early study on the relative merits of different types of drawings Ayer[3] found that, (1) The highest type of laboratory instruction is attainable only by adapting procedure to the individual differences in ability to draw and to use graphic expression. (2) "It is a waste of time in the interests of scientific thinking to require students to spend extended periods of time at representative drawing. In fact, it is worse than a waste of time, for it encourages bad habits of analytic study which are opposed to the interests of scientific and constructive research . . . The excessive use of representative drawing is a serious pedagogical formalism which produces copyists instead of scientists and which creates distaste instead of enthusiasm for science." (3) "The results of the various special tests show that representative drawings do not afford a measure of the pupil's progress, or an adequate record of the work which he has accomplished . . . Not only does representative drawing fail to aid the memory, but, as far as scientific concepts are concerned, even interferes with it." These conclusions with respect to the relative merits of representative and diagrammatic drawings were later substantiated by Bryson[4].

The studies of Ayer, Bryson and Baird all point to the conclusion that the representative type of drawing is a sheer waste of time. Yet according to Ballew and Baird the majority of required biological drawings are of this type. Hunter[5] deplores this situation in his analysis of the misuse of the laboratory.

Can it be that the lack of ability to draw and the consequent poor drawings are responsible for the poor results obtained by this method? Using as his subjects a university freshman class in zoology, Colton[6] investigated various factors affecting improvement in making laboratory drawings. He concluded that in general those students who, at the time of entering the course, are able to observe and record make no further effort at improving their technique and in some cases fail to maintain the same degree of excellence, and that a small amount of training in drawing results in great improvement on the part of those less capable in this respect. However, the writer questions whether the time spent in training to improve drawing has been profitably spent so far as learning biology is concerned.

Though most will agree that the making of pencil portraits of laboratory specimens be banned, many may

still argue that drawing does help in analyzing and remembering observations. Ballew[7] conducted a carefully controlled experiment to determine whether pupils are better able to remember details of zoological structures and to make comparisons and analyses when they construct and label representative drawings of the structures than when they merely locate the same structures on the specimen, without drawing it. He found the construction of representative drawings does not aid the pupil in making analytical observations of material under study, nor in remembering observations made in the laboratory. He concludes, "It would seem advisable to omit representative drawings from laboratory procedure and to replace them with supplementary work, thereby enriching the course."

The argument here is not against biological drawings *per se*. On the contrary, a diagram in the textbook, on the blackboard, or on mimeographed sheets affords an excellent means of concretizing an exercise or discussion which tends to be vague without it. Although we cannot expect all pupils to make presentable laboratory drawings, the ability to make clear, rapid drawings on the blackboard should be a requisite for all biology teachers. Often such drawings have more pedagogic value than models or charts. Huebner[8] investigated the relative effectiveness of models, charts and teachers' drawings as aids to the teaching of botanical structures in high school classes. She concluded (1) that the pupils as a whole gained a greater factual knowledge with the aid of models and of teachers' drawings than with charts, (2) that the value derived from good diagrams can be made to approach closely the value derived from models, which are frequently very expensive, and (3) that proper training increases the pupils' ability to interpret the diagrammatic blackboard drawing.

Where the student encounters great difficulty in drawing it is doubtful whether the added time spent in producing only a fair drawing has been profitably spent. Where laboratory drawings are graded, there is the tendency to mark on excellence of line work rather than on factual depiction. In any event, the correlation between the excellence of laboratory drawings and achievement in laboratory work has not been established. Where the quantity or quality of laboratory drawings is stressed, emphasis tends to be shifted from the materials under observation to the making of numerous or artistic drawings.

A widespread use of a teaching device which consumes a great deal of time and which is subject to such frequent misuse raises an important problem as to its desirability. Must the student make drawings to learn? Will he retain his knowledge as readily if he does not represent on paper what he sees with his eyes? Is a poor and inaccurate drawing which represents the best efforts of an inferior student worth the time it has taken to construct? Can ready-made drawings be used as a tool for acquiring knowledge just as the other laboratory equipment is used?

In line with the present increase in the use of visual aids, prepared drawings are being substituted for student drawings. With the new procedure the student makes his laboratory observations, and, instead of drawing, merely labels prepared drawings. These drawings may be found in workbooks, purchased separately from biological supply houses, or better still, made by the instructor on mimeograph stencils. These latter have the advantage of being cheap, and of including only those features which the instructor deems essential for the particular needs of his class. Figure 1 emphasizes the relative positions of the organs of the frog rather than being simply a representation of the actual dissection.

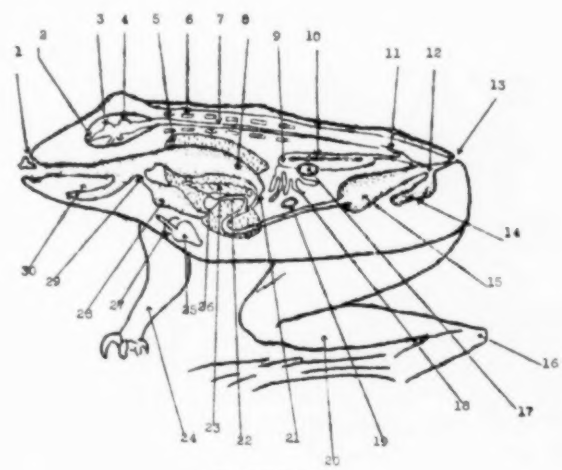

FIGURE 1

DIAGRAMMATIC SKETCH OF THE FROG DISSECTED FROM THE LEFT.

Those who advocate the prepared drawing claim that it can be substituted in full, or in part, for the student drawing with no loss of efficiency on the part of the student to observe or remember. Their main argument is that of time saved. Can this time be spent more profitably on the observation and dissection of the specimen, and the use of other visual aids such as motion pictures, lantern slides, models, charts, modeling in clay, et cetera?

In a recent investigation by the writer[9] to determine the relative effectiveness of student-made and prepared drawings, two groups of college students taking general biology were equated for (1) Intelligence, (2) Registration for Science or Non-science degree, (3) College Class, (4) Number and kind of previous science courses, (5) Intention to major in biology, and (6) Previous record in biology. The research was limited to a three-week period on the laboratory study and dissection of the frog. The unit on the frog was chosen, first, because it afforded a short but significant period of work, and second, because it occurs so frequently in the curricula of high schools and colleges, and thus comprises a set of typical laboratory exercises.

The same set of laboratory outlines was followed by all students. The laboratory outlines require the

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The Museum Brings The World To The Class Room

● By Arthur C. Parker, M.S., (*University of Rochester*)
DIRECTOR, ROCHESTER MUSEUM OF ARTS AND SCIENCES

"The museum is the latest development in the field of creative education."

There is truth in this statement.

Museums are no longer merely places for the storage of collected materials. They are becoming truly dynamic influences in the community. No longer do they wait for people to come to them. Through their extension divisions they are going to the people. The valuable service that Rochester provides for its schools through its Museum is here described by its progressive Director.

A similar service, even in a limited form, may already be available in your district, or can be begun. Why not bring this article to the attention of the director of your nearest museum?

●

Museums in the United States, especially those supported by public funds, within the past ten years have adopted an entirely new attitude. The old plan of accumulating collections as a by-product of research, or of merely gathering objects for visible storage, has given way to the better plan of presenting exhibits for direct teaching purposes.

It will be observed that the more active museums now construct their exhibits for a very definite purpose, arranging them in natural sequences, or constructing dioramas that present a subject in its logical setting. This relegates the large classified collections to storage cases, easily available to students. Thus, a natural history museum of repute now builds groups showing models of fossils as they must have appeared in their living forms, and presents the reconstruction against a background painted to show the natural habitat. The foreground, also, is carefully filled in with proper accessories. This scheme is followed for practically every form of life, making more understandable the classified collections in glass-topped drawers or in the laboratory study.

The new industrial museums follow a similar procedure and present the story of industry, industrial apparatus and the results of the machine age, in such a manner that the student easily grasps principles and operative methods.

Thus the museum emerges from the cloistered hall and seeks to become useful to the general public and the schools, as well as to the research scientist.

The first step has been taken, but a further step is necessary if the museum is to become an energizing factor in the community that it attempts to serve. Some of the larger museums have now taken this second forward step, leading to the outer world. In this manner Extension Divisions of museums have been organized and equipped to take the museum to the people who need museum material at the desk, in the class room, or upon the lecture rostrum.

One of the first institutions to adopt a vigorous extension service was the St. Louis School Museum. The American Museum of Natural History soon took up the plan, and not far behind was the Newark (N. J.) Museum, under the leadership of John Cotton Dana. For enrichment purposes in the field of natural history the Field Museum of Natural History has a similar plan, sending out numerous zoological exhibits.

The soundness of this plan has impressed the Rochester Museum of Arts and Sciences, but one further step has been taken to make the idea even more effective. This is to deliberately attempt to illustrate the school curriculum by means of museum objects. Fortunately the Rochester public school system has a published syllabus giving in detail each specific project and its objective.

For six years the Rochester Museum has gathered objects from the uttermost parts of the world, stressing the social sciences, but not neglecting natural and physical science. Models of machinery, ships, vehicles, small habitat cases of insects, birds and small mammals have been constructed; scores of charts have been prepared by artists and model makers displaying objects and pictures; moving picture film and lantern slides are added to the grouping, and finally a selection of objects and articles is brought together in a box, duly tagged and labeled. All this is available to the teacher in public, parochial or private school. The museum truck delivers directly to the teacher's desk, and picks up the collection at the expiration of the use-period. No charge of any kind is made for this service.

The museum is continually adding to the illustrative material, building up its selections as suggested by teachers. In no way does the museum seek to send out objects merely for the sake of making a shipment. On the other hand it only sends what the teacher has specifically ordered for a particular purpose. There are no cryptic numbers or call symbols. The teacher simply telephones for the museum's equipment designed to illustrate some specific need. This may vary with the class or with the school. The museum is supposed to know what the problem is and to meet it. Thus, material for a third year academy student would not be the same thing that would be sent the fifth grammar grade in any such subject as water, Chinese exports, Hungarian costumes, or spring flowers.

In many instances the lending collections are extensive and very valuable. Much of the material is made

Continued on Page Twenty-five

Individual Nature Study Projects

In the High School Biology Course

● **By Pressley L. Crummy, Ph.D.,** *(University of Pittsburgh)*
BIOLOGY DEPARTMENT, JUNIATA COLLEGE

The ability to excite curiosity and to make students interested in and inquisitive about the life around them, is the mark of a good teacher of biology. Readers of this article will know why Doctor Crummy always has interested classes. With Agassiz, he believes in studying nature, not books.

Some high school teachers of biology would like to use the project method but they do not know how to proceed. This article will help them. An experienced biologist writes it, one who is skilled in the work and who is willing to tell others about it.

A list of practical projects is included.

●

Biology, the science of life, is one of the subjects of study which above all others should be of intense interest to the high school student. The subject is concerned with the happenings of the student's everyday existence. The basis of scientific endeavor is an inspired curiosity, and what young person of high school age isn't curious about the life around him? Even in the city where wild life is relatively scarce many forms of living things are to be seen, and some, such as flies and mosquitoes, impress themselves quite forcefully upon the observer's attention. Yet, in spite of natural curiosity and the presence of abundant living material the study of which would satisfy that curiosity, this part of the school curriculum is too often just another monotonous course.

A hundred years ago, that noted biologist, Louis Agassiz, is supposed to have said that we should "study nature and not books." Such advice is just as true today as it was then. It is probably correct to say that we cannot satisfactorily divorce our study of nature from a study of books, but we certainly cannot study nature successfully from books alone nor even from books supplemented only by dead and ill-smelling preserved plants and animals. It is the job of the biology teacher in the secondary field to make his course a living one. Even the oversensitive and squeamish girl who "couldn't bear the thought of touching a slimy fishing worm" can very easily become interested in plants and flowers or, perhaps, butterflies and moths.

Many of our biology teachers are quite successful in arousing interest in the study of natural objects, and the communities in which they work are justly proud of them. These successful instructors will tell you that one must be enthusiastic about his work before he can hope to stir anyone else into interested activity. A commonly used method of bringing the course to life is that of taking the class out of the schoolroom and into the open on frequent field trips. This procedure is excellent but of itself does not go far enough. In many cases it is very nearly, if not entirely, impossible to carry out with any satisfaction. Even when field trips can be and are taken, they are not always desirable. In many instances a much more desirable procedure would be that of having a few or even one interested student do some particular piece of work on his own initiative. The instructor must encourage such interested individuals to do this work and be willing to advise them in the proper method of procedure. Such activity is well adapted to arousing new interests, for the student is using his own hands and eyes and is learning things for himself.

Should we then, abandon any attempt to take our classes on field trips? Decidedly not, for the class trip does have a definite place in the high school biology course. It is, in fact, a very necessary feature of the course. No other method so satisfactorily serves to introduce the members of the class to the many forms of life about them as that in which an instructor takes a group out into the great outdoors and points out interesting objects and facts of nature.

It is on such an excursion that attention can be directed to various things of particular interest, one or more of which may serve to arouse the curiosity of some individual who until then may have been a listless and ambitionless trouble-maker. Far from being the least important use of the class field trip is that of breaking the monotonous routine that a teacher is certain to fall into at times. Furthermore, such an exploration serves to enliven the course and helps the teacher to make the study of biology the living, intensely interesting, and inspiring activity that it should be.

So much for the importance of the field trip. What about its drawbacks, and its difficulties of operation? In the first place, in order that it be successful, the teacher must devote considerable time and effort to the planning of each trip. Unless he is very carefully prepared, he will find that the class has too many other interests to be bothered by listening or looking at what is being pointed out by the instructor. Perhaps the chief difficulty to be encountered is just that matter of diverse interests. While a few are examining some particular plant or animal or other natural object, the others are wondering about something else.

Another important handicap to frequent journeys into nature's own laboratory is lack of time in the rigid

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The Pontifical Academy of Sciences

• **By Sister Mary Fidelis, O.M.**
MERCYHURST COLLEGE, ERIE, PENNA.

The personal interest of Pope Pius XI in science is reflected in his revival of the ancient Academy of Sciences, and in his decision to increase its numbers and to open its membership to eminent scientists, non-Catholic as well as Catholic, throughout the world. The Academy now becomes truly international in character. Its importance is enhanced by the special interest of His Holiness. Its work may become of great significance.

The recent appointment to membership of several outstanding scientists from the United States is directing the attention of Americans to this little known scientific group.

Sister Fidelis discusses the founding and development of the Academy.

•

The age-old, alleged controversy between Church and Science has recently been brought into the limelight by the Holy Father's nomination of non-Catholics for membership in the Pontifical Academy of Sciences. The six new American members, three of whom are non-Catholics, are: Dr. Alexis Carrel of the Rockefeller Institute, New York; George Sperti of the Institutum Divi Thomae of the Catholic Athenaeum of Ohio, and Hugh Stott Taylor of Princeton University, Catholics; George David Birkhoff of Harvard University, Robert A. Millikan of the California Institute of Technology, and Thomas Hunt Morgan of the California Institute of Technology, non-Catholics.

Interesting, indeed, is the history of this Academy, whose work is being revivified by a keenly interested Pontiff. Dating from August 17, 1603, it was founded by a Prince of Rome, Federigo Cesi, Marcese di Monticelli, a distinguished scholar and patron of letters. Assembling a number of scholarly persons in his palace, he founded the "Accademia dei Lincei," so-called from its emblem. The device of the Lincei was a lynx, with its eyes turned towards heaven, tearing a Cerberus with its claws, intimating that the members were prepared to do battle with error and falsehood. Their motto was the verse from Lucretius describing rain dropping from a cloud: *Redit agmine dulci.*

This intellectual circle was worthy of high praise, for it changed the prevalent tendency to purely literary studies by promoting the study of the exact sciences, of which it became the chief academic centre in Italy. Under the patronage of Cesi, many valuable publications were effected, among them a vast, unedited natural history of Mexico by Francesco Hernandez, a history of rare plants by Fabio Colonna, a colleague of Cesi, and works of Francesco Stelluti, who was procurator-general of the Academy in 1612. Its famous members, Galileo Galilei of Italy, Johann Faber of Bamberg, Marcus Velser of Augsburg, brought it much renown. The death of Prince Cesi spelled disaster for the Academy, for, despite the efforts of his successor, Cassiano dal Pozzo, after 1652 it fell into oblivion.

Under Pope Pius IX learning was again stirred. He resuscitated Prince Cesi's society as an academic centre for physico-mathematical studies. On July 3, 1847, the *Pontificia Accademia dei Nuovi Lincei* was founded. The Holy Father inaugurated it personally the following November, and endowed it with an annual income from the pontifical treasury. By this new organization, the members were divided into four classes: honorary, ordinary, corresponding, and associate. The last were young men, who, on the completion of their studies, showed special aptitude for the physico-mathematical sciences. The Academy was directed by a president, a secretary, an assistant secretary, a librarian-archivist, and an astronomer. Its headquarters were in the Campidoglio.

In 1870, a group of the members withdrew from the Academy. They called their organization the *Regia Accademia dei Lincei.* It received the approval of the Italian government, and was subsidized by it in 1875. With the Corsini Palace as headquarters, they enlarged their scope so as to include studies of moral, historical, and philosophical characters. The *Pontificia Accademia dei Nuovi Lincei* continued its labors in the Cancelleria Apostolica under a cardinal-patron.

Early in his Pontificate, Pope Pius XI established the Academy in the Vatican gardens, so that he would be more readily able to keep in touch with its labors and to encourage its members with his personal interest. Now the Motu Proprio *In Multis Solaciis* has instituted a radical reform of the Academy in accordance with the needs of the times and has promulgated statutes for future guidance.

According to the new pattern, the Pontifical Academy of Sciences will consist of seventy members, personally nominated by the Supreme Pontiff. These will be selected from among the most eminent cultivators of positive science throughout the world. With His Holiness directing them, these members will form a scientific senate to which the Holy See may turn for research in scientific fields. To be a Catholic is not an absolutely necessary condition for membership; non-Catholics may also be members, provided they are scientists of exceptional worth, and their scientific activity is not contrary to the respect which is always due religious sentiment and faith in God.

The following is taken from the Motu Proprio *In Multis Solaciis:*

> "Among the many consolations with which Divine Goodness has rejoiced the years of our Pontificate, we like to enumerate those afforded by the spectacle of so many men who have dedicated them-

Continued on Page Thirty

Fr. Nieuwland Commemorated

● **By Frank Thone, Ph.D.,** *(University of Chicago)*
SCIENCE SERVICE EDITOR IN BIOLOGY, WASHINGTON, D. C.

Scores of scientists, eminent in their respective fields, and hundreds of educators, business men, and others prominent in public life, recently gathered at the University of Notre Dame to pay honor to the memory of the late Dr. Julius A. Nieuwland, for years director of organic research at the university.

Dr. Thone gives a brief account of the memorial exercises.

Father Nieuwland was world famous as a chemist. A story of his life appeared in the June, 1935, issue of the SCIENCE COUNSELOR.

●

Notre Dame University on Sunday, January 10, celebrated the memory of one of the most famous of its alumni, the late Father Julius Arthur Nieuwland. At the memorial exercises scientists from universities and industrial laboratories vied with old-time fellow-members of the Notre Dame faculty to set forth his claims upon the recognition of future generations.

As if to stress Father Nieuwland's double dedication, to Church and Chemistry, the exercises were divided into two parts. In the morning there was a solemn High Mass, at which the sermon, "Religion and Science," was preached by the Rev. Francis J. Wenninger, C.S.C., dean of the college of science at Notre Dame University.

In the afternoon the speakers were Prof. George D. Birkhoff of Harvard University, newly-elected president of the American Association for the Advancement of Science, Prof. Arthur Haas of Notre Dame, Prof. Marie Victorin of the University of Montreal, Prof. Hugh S. Taylor of Princeton University, Dr. Marcus Ward Lyon, formerly of the U. S. National Museum, and William Stansfield Calcott, director of the Jackson Laboratories of the E. I. duPont de Nemours Company.

Although his popular fame rests chiefly on his work as a chemist, Father Nieuwland's actual working years in chemistry were comparatively brief, though astonishingly productive of solidly meritorious discoveries, declared Mr. Calcott, in whose laboratory Father Nieuwland's most noted chemical discovery was developed to the point of commercial use. For ten years after he received his graduate degree in chemistry, Father Nieuwland worked principally in the field of botany. Then he returned to chemistry, but for several years more he published very few research results, though he was busy all the time.

This apparent sterility was due to his insistence on knowing all the facts before he said anything, Mr. Calcott pointed out. The very discovery for which he is best known supplied the duPont research leader with a text in point. Father Nieuwland, making up a compound of acetylene, noticed that the resulting gas did not smell exactly "right." He did not know whether the strange odor was due to the presence of divinyl acetate or to some other gas. He returned to this problem again and again for several years, until he finally tracked it down. The strange-smelling gas *was* divinyl acetate—now the basis of a major industry in synthetics.

Father Nieuwland devoted practically his whole chemical career to the investigation of just one group of phenomena—the reactions of the compounds of acetylene. He wrote his doctor's thesis on this subject, and stuck to it ever after—a thing scientists seldom do. Acetylene compounds are ordinarily explosive and "tricky," but he did not mind this danger. Mr. Calcott related that once when Father Nieuwland made up the gas later known by the wartime name of Lewisite, he decided to let it severely alone thereafter. Poisons were not in his line.

Botany, his second career, occupied much of his teaching and research attention at Notre Dame, and was his avocation when he finally made chemistry his main task. Dr. Lyon devoted his address to this aspect of Father Nieuwland's work.

The noted priest-scientist was especially interested in the flora of acid lands, and often spent whole days striding through the plains of southern Michigan or the pine-barrens of the Atlantic Coastal Plain, alone or with a few devoted students trotting breathlessly at his heels—for he could walk younger men tired. Once, at a meeting of the American Chemical Society in a Florida city, he got a chance fellow botanist into a hotel corner, not to talk chemistry but to discourse enthusiastically on the tall golden-leaved pitcher-plants he had seen in the surrounding sandy pinelands. His wide knowledge of the classic literature of botany helped him to build up an exceptional botanical library for his university. Characteristic was his own personal bookplate; a flower design, and the verse, in Vulgate Latin: "Consider the lilies of the field."

The famous theory of cosmogony of the expanding universe, which postulated some primeval explosion that sent the stars and galaxies rushing apart, was given a serious blow in the address of Prof. Arthur Haas, famous Viennese theoretical physicist now on the staff at Notre Dame University. Prof. Haas presented mathematical arguments and calculations showing that the famous observed red-shift of light from distant nebulae can hardly be due to an expansion, or rushing away, of these cosmic bodies from some central point. The interpretation of the red-shift as due

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Elementary Science

Continued from Page Three

factions and the mental stimulation resulting therefrom, life becomes uninteresting and vegetative in character.

3—The Scientific Attitude

As pupils learn to be free from prejudices and base their conclusions on facts, they develop habits of thinking which may be applied not only toward further accumulation of scientific information but also toward the solution of personal or social problems that may confront them in every day life. Practice in such application is essential, otherwise the transfer of this method of science to other fields does not follow easily.

4—Social Implications

The social and economic order is in large measure a result of the discoveries in pure science—the discovery and control of fire, for example, made it possible for man to extend his habitations to climates that would otherwise be too severe. The discovery of steam power and electricity has completely revolutionized civilization within the last one hundred years. In our own generation, the development of the automobile and the radio has changed our whole economic and social life. Is it not a rightful part of every child's inheritance that he should have the opportunity to understand, for example, the scientific basis of the automobile and radio, or in the absence of an opportunity

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CONTENT AREAS	GRADE 1	GRADE 2	
I THERE ARE MANY KINDS OF LIVING THINGS ON THE EARTH	**I—1 Plants and animals live almost everywhere** (1) Animals live all around us (2) Animals eat different foods (3) Animals have different ways of moving about (4) Plants can not move about as animals do	**I—2 Animals must have food** (1) Animals eat many different kinds of food (2) Animals have different ways of getting their food (3) Animals are protected from attacks by other animals	**I—3 Plants** (1) Most (2) Plants (3) Most
II EARTH CONDITIONS ARE CHANGING	**II—1 Our earth is made up of air and water and land** (1) The land is made up of rocks and soil (2) Water is found almost everywhere (3) Air is all around us (4) Plants and animals must have water and air	**II—2 The weather is always changing** (1) The air is warm sometimes and cold sometimes (2) Living things must have water (3) Living things prepare for winter (4) Living things are more active at some seasons of the year than at others	**II—3 Our** (1) (2) The (3) The (4) The
III MATTER AND ENERGY ARE SUBJECT TO MANY CHANGES	**III—1 Air surrounds us** (1) Air takes up room (2) Wind is air that is moving (3) Air has water in it (4) Air makes fire burn	**III—2a Water passes through many changes** (1) Water may change its form (2) Water is moved from place to place (3) Living things use water (4) Water dissolves many things **III—2b Magnets push or pull things** (1) Magnets pull some things toward them (2) We can make magnets (3) A magnet can push or pull another magnet (4) A magnet can be used for a compass	**III—3a Heat** (1) We (2) We (3) Heat (4) Plants **III—3b Work** (1) Men (2) There (3) People
IV THE EARTH IS A SMALL PART OF THE UNIVERSE	**IV—1 The sun, moon and stars are in the sky** (1) We can see many things in the sky (2) The sun gives us heat and light (3) The moon gives us light (4) The stars are like our sun	**IV—2 The earth is a heavenly body** (1) The earth is round like a ball (2) The earth is very big (3) The earth pulls everything toward it (4) Empty space surrounds the earth	**IV—3 Our** (1) The (2) The
V PLANTS AND ANIMALS SURVIVE MANY CHANGES	**V—1 Plants and animals are more active in the spring** (1) The days get longer in spring (2) Trees begin to grow in spring (3) Seeds sprout and grow in the spring	**V—2 Animals have their young** (1) All animals have parents (2) Many animals lay eggs (3) Some animals have living young	**V—3 New** (1) New (2) Some (3) Parts (4) Some
VI LIVING THINGS ARE INTERDEPENDENT	**VI—1 We get our food from plants and animals** (1) We eat various parts of plants for food (2) Some of our food comes from animals (3) Some foods are better for us than others	**VI—2 We should take care of many animals** (1) Animals help us in many ways (2) Pets and domestic animals need our care (3) Many wild animals need our care and protection	**VI—3 Many** (1) We (2) Plants (3) Our (4) Trees,

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for understanding should he regard these inventions as machinations of scientific wizards, very much as his early ancestors worshipped fire?

A PROGRAM IN SCIENCE EDUCATION

Because of the basic importance of the field of science, as previously indicated not only for the inherent values that are available, but for the fundamental implications in other fields, it is believed that there is justification for a twelve year program in science for our school system. Contrary to the apparent beliefs of early educators science cannot be taken as a dose of medicine for a temporary effect, to be immediately forgotten. Pupil interests and needs in the various elementary and secondary school grade levels are such that continuous experience in the field of science is necessary for well-rounded intellectual growth.

In the past, isolated courses in science have been organized and taught in our schools with no opportunity for long continued growth in any one direction. It is believed that a program in science education should be so organized as to provide pupils with experiences that are appropriate at each level of instruction and that broaden year by year their horizon of interests and understandings in science.

CURRICULUM PROBLEM

Naturally enough, the development of the science program has paralleled the progress of the race in science knowledge. In the elementary grades, as in

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ELE TARY SCHOOL SCIENCE

ADE 3	GRADE 4	GRADE 5	GRADE 6
ts ma ed ost p their own food ants different ways ost p their seeds	**I—4 Some plants and animals live in communities** (1) Many plants live in groups or societies (2) Many animals live in communities (3) Some animals live together at some times and not at others (4) We live in communities	**I—5 Plants get their food in different ways** (1) Green plants make their own food (2) Nongreen plants do not make their own food (3) Some nongreen plants get their food from dead materials (4) Some nongreen plants get their food from living things	**I—6 Animals need food for growth and energy** (1) Animals use food for different purposes (2) Animals are made up of cells (3) All cells must have food and oxygen (4) In higher animals groups of cells perform special functions
r earth s changing us is changing changing for a long time is being worn down in earth is being built up in	**II—4 Plants and animals have lived on the earth for a long time** (1) We can find out what happened long ago by studying the rocks (2) Plants and animals of the past have left their record in the rocks (3) At certain times there seemed to be more of some kinds of plants and animals than of other kinds (4) The plants and animals of the past were very different from those of today	**II—5 Seasons are caused by changes in the earth's position as it revolves about the sun** (1) The earth has three principal motions (2) The earth's axis tips as the earth goes around the sun (3) We get less sunlight in winter than in summer (4) The motion of the earth is our measure of time	**II—6 Weather and climate are constantly changing** (1) The earth's climate in the past has been stormy and changeable (2) Living things must adapt themselves to weather and climate (3) Weather and climate depend upon many factors (4) The weather may be predicted
Heat from the sun many ways a thing is one thing to another must have heat Work easier tools to help them work kinds of machines use natural forces to help them work more easily	**III—4a We can get electricity in several ways** (1) Rubbing things together gives us one kind of electricity (2) We can get useful electricity in several ways (3) Electricity will travel through some substances better than others **III—4b Light enables us to see things** (1) Some objects give off light directly (2) Light is reflected by many objects (3) Light rays may be bent away from a straight line in passing from one substance to another (4) Some substances absorb more light than others	**III—5a Substances are always being changed** (1) Substances are either solids, liquids or gases (2) Many things change naturally (3) Many things can be changed by man (4) Some substances are elements (5) All substances are made of elements **III—5b A layer of air surrounds the earth** (1) Air has weight (2) Objects that are lighter than air will float in the air (3) Man has learned to fly in machines that are heavier than air	**III—6a We can make electricity work for us** (1) Magnets can be made with electricity (2) We use electricity to communicate with others (3) Electricity is a convenient source of power (4) Electricity can give us heat and light **III—6b Sound travels through many things** (1) We can make sounds by causing things to vibrate (2) Sounds vary in pitch, loudness and quality (3) Sound must be carried through something in order to travel from one place to another (4) Our ears are fitted to hear sounds
ur earth he earth like a top he earth around the sun	**IV—4 The moon is the nearest heavenly body** (1) The moon moves around the earth (2) The moon is a dead world (3) We see only the part of the moon that is lighted by the sun (4) Eclipses are caused by earth and moon shadows	**IV—5 The earth is a member of the solar system** (1) The earth is one of nine known planets that revolve about the sun (2) The solar system includes many other kinds of heavenly bodies (3) Scientists now believe that the various bodies in the solar system were once a part of the sun	**IV—6 The sun is a member of our galaxy** (1) Our sun is only one among millions of stars (2) Groups of stars that form imaginary patterns we call constellations (3) The stars in our galaxy are grouped in the form of an enormous disk (4) There are many universes besides our own
w plants uced in several ways ew p from seeds ome bulbs arts plants will grow into new plants ome longer than others	**V—4 Flowers are necessary to produce seeds** (1) There are two parts of a flower necessary in the production of seed (2) Pollen necessary for fertilization is carried in several ways (3) Fertilization is necessary to the production of seeds	**V—5 Living things are always changing** (1) Living things pass through different stages of growth (2) Young resemble, yet differ from their parents (3) Some plants and animals are better fitted to live than others (4) Both desirable and undesirable qualities may be inherited by offspring	**V—6 Man has changed some plants and animals so that they are better suited to his needs** (1) Man has domesticated many plants and animals (2) Domesticated plants and animals have been improved by selection (3) Some new varities of plants and animals have been produced
any pl our protection and care e many ways lants ways to protect themselves ur and farm plants need speci rees, and other plants need protec	**VI—4 Plants and animals depend upon each other** (1) Plants and animals depend upon each other in the balanced aquarium (2) Land plants and animals depend upon each other (3) The numbers of each kind of plant and animal remains about the same from year to year (4) Man often upsets the balance of nature	**VI—5 We should conserve our natural resources** (1) The soil is the most important of our natural resources (2) We should conserve many plants (3) Our animal life should be conserved (4) Our sources of energy should be used wisely (5) The natural beauty of our country should be conserved	**VI—6 Our health should be safeguarded** (1) Our bodies must be kept in good running order (2) We must have good food and water (3) Our homes should be clean, well-lighted and well-ventilated (4) Our communities must be managed to preserve the health of all citizens (5) We must cooperate to control disease

prehistoric days, the interests are broad, curiosity has no limits or even direction, and the program is confined to no one special field. Our elementary science syllabus materials, for example, may be described as of the integrated variety. The same may be said of general science for the seventh, eighth and ninth years. In the senior high school, the opportunities for specialization first appear. It is only fairly recent in the history of the race that man organized scientific knowledge in special divisions or fields. This organization was a natural and logical development. The implication here is that it is natural and logical at the secondary school level to concentrate pupil efforts in more specialized areas. No one can say with authority just where this specialization should begin. Our present courses in biology, physics and chemistry in the tenth, eleventh and twelfth years are by no means special courses. They are broad environmental offerings that cut through all the lines of division of the several sciences.

In a sense, a general biology course is a misnomer since it includes botany, zoology, bacteriology, anthropology, geology, taxonomy, evolution, genetics, eugenics, euthenics, organic chemistry and a considerable amount of other biological and physical sciences. Our physics course may be described as the physics of our environment and the chemistry course is nothing more than the chemistry of our environment, including both biological and physical phases. In my opinion this organization of materials presents many desirable possibilities.

ELEMENTARY SCHOOL SCIENCE

The only sound approach to the construction of a twelve year sequential program in science is to start from the bottom and work toward the top. We are therefore primarily concerned at the present time with the development of a satisfactory program in elementary school science. After this program has been well established in the elementary schools, reorganization of general science for the seventh, eighth and ninth grades will follow with later revisions of the biological and physical science syllabuses to be based on the foundation laid by the elementary science and general science courses.

In developing an elementary school science program, a syllabus committee is confronted with a number of serious problems. Among others the following may be mentioned:

1. What are the educational interests and needs of elementary school children?
2. What form of educational planning should the elementary school curriculum provide?
3. What natural science experiences are within the interest and comprehension ranges of children at various learning levels?
4. How do children learn?
5. How may worthwhile experiences in natural science best be provided in the elementary school program?

A suggested revision of the New York State Science syllabus is outlined in the accompanying science chart. The proposed organization of material is based upon the reactions and experiences of thousands of classroom teachers and supervisors throughout the State. Basically, the content materials of the early syllabus and the present proposal are the same. The organization of these materials, however, is different, and we hope, considerably improved. In the present revision an attempt was made to accomplish the following aims:

1. To simplify the syllabus organization for better understanding and use.
2. To obtain a more satisfactory seasonal arrangement of materials.
3. To construct a syllabus that would lend itself readily for adaptation to rural schools, traditional graded schools, activity schools, and other types of school organization.
4. To organize in suggested unit teaching form materials that might form the nuclei or important parts of larger activity units.
5. To encourage a broad integrated type of program as opposed to the development of a disjointed and unrelated series of small isolated units of experience.
6. To encourage an activity program in science as opposed to the purely teacher authority or reading program.

In an effort to accomplish the aims listed above, the whole field of science was divided into six convenient areas of experience. These six *content areas* were then arranged in what seemed to be a natural and desirable teaching order, as shown in the accompanying outline. The development of each *content area* is illustrated by the sequence of teaching units suggested by grades in each horizontal column. Vertically, each column represents a suggested program in science for one elementary grade from September to June. Attention is called to the fact that the first content area, which comes in the fall of the year, is mainly biological. The same is true of the 5th and 6th content areas which come in the spring of the year for each grade. This arrangement makes seasonal adaptations possible in all types of schools.

It is important to note that, while the center of interest in one *content area* may be biological or physical in nature, related materials from the whole field of science are usually appropriate as suggested by the *learning elements* listed under many of the *teaching unit titles*. In other words, the science content is integrated around centers of pupil interest which may be classified as principally biological or physical in nature.

The plan of organization suggested in the chart has many advantages. A few may be listed as follows:

1. The teacher is permitted to prepare herself, in one field at a time, for teaching a content area as, for example, astronomy.
2. She can much more readily obtain and organize references in one field at a time rather than scatter her energies in this direction over the whole field of science.
3. Materials of all kinds appropriate for pupil observation and simple experimentation may be organized around each content area. These materials may be used for learning purposes at each level of instruction. Again, it is evident that this is preferable to a plan whereby the teacher would attempt to organize materials for teaching in a wide range of fields.
4. When teachers concentrate upon one field as represented by each content division, they can

appreciate readily the plan of continuous development, the possibilities of pupil growth in experiences within that field and the appropriate stages, steps, or levels of experience and growth involved.

5. Teachers may reasonably expect greater assistance from their supervisors under the suggested plan of syllabus organization since supervision is greatly facilitated when the emphasis is upon one content area at a time.

No field of instruction lends itself more readily to the activity type of program than science. In science, pupils learn by observation, by doing things, by carrying on experiments. Reading materials, textbooks and reference books are helpful but should be strictly supplementary to real science experiences on the part of pupils. These experiences will probably take the form of class experiments and teacher demonstrations in many instances. In addition, simple individual pupil projects and experiments in school and at home are indispensable.

In developing a continuous and integrated program in science, it is necessary to have a definite organization of materials for each grade level. Teachers at each grade level should be in a position to know what the pupil experiences for the previous grade have been, and what appropriate science activities may be planned that will not interfere with the work of the following grade. This principle should operate, regardless of the elementary school organization, as of the traditional, activity, or other type. There is almost unlimited opportunity in each grade for teachers to guide pupil interests in directions that will enrich the child's science experience without violating the limits of content suggested for each grade.

It is true, of course, that no one knows just what can or should be taught in science to elementary school children. This proposal presents a plan of organization that has been tried out experimentally and found to be reasonably satisfactory. Naturally as we increase our knowledge of child psychology and as we learn more about science teaching, revision and modification of our elementary science program will be in order. It is only through cooperative trial and research on the part of classroom teachers that we can hope to make progress.

Furthermore, in such experimentation, it is essential that advantage be taken of progress made and knowledge obtained on the basis of past experience and investigation. An attempt has been made in this outline to take full advantage of the findings and experience of teachers and research workers in the field of elementary school science.

TEACHER TRAINING PROGRAM

Fortunately, in the teaching of science, perhaps more than in any other field, a teacher's attitude is much more important than her actual knowledge. No teacher, elementary, high school, or college, can be a master of all scientific information. No teacher of science can afford to pose as an authority even in a narrowly restricted field of science. And contrary to popular belief the admission of lack of knowledge does not lower the prestige of the classroom teacher. She can learn with her pupils and is encouraged by circumstances to adopt a most stimulating scientific method in the introduction of science materials in her program. This attitude referred to, however, usually comes after a considerable amount of training in science. It is therefore believed that definite steps should be taken by school administrators to provide the proper training in service for their elementary science teachers and to encourage the development of this attitude.

High schools usually have well trained teachers of science on their faculties and provide satisfactory laboratory facilities in both the biological and physical sciences. It is suggested that it should be possible for superintendents to organize elementary school teachers as science study groups to meet once or twice a month throughout the school year. It is further suggested that these groups be conducted under the leadership of the most capable general science teacher available. The general science teacher should take the point of view that he knows little or nothing concerning methods of teaching at the elementary school level. His primary concern should be to organize science work for these elementary school teachers in order that they may in turn adapt appropriate content, methods and materials to their own classroom situations. The high school laboratory should provide adequate opportunity for each teacher to perform simple experiments, to stock aquaria, to build animal cages, to arrange collections and to perform many of the activities that they may use in their own schools.

Such a study course for elementary school teachers may be organized on the basis of the elementary school science chart and with comparatively little effort on the part of the general science teacher. Groups of this sort have been started in several of our rural and city school systems. In each case the elementary school teachers have welcomed the opportunity to acquaint themselves at first hand with this comparatively new field. The enthusiastic reports received suggest that the plan might well be extended. For best results it is suggested that the work be planned on a purely voluntary basis. The lack of properly trained teachers should not be used as an excuse for not introducing science as a regular part of the elementary school curriculum. It is possible for every superintendent to capitalize the professional interests of his high school science and elementary school teachers in a cooperative study group plan and thus prepare teachers for the introduction of science in the elementary school program.

Finally, may I state that the introduction of science as an integral part of the general elementary school program presents unusual opportunities for educational leadership. In this field we have a content that is fundamentally satisfying to young children, a content saturated with human drama and interest, a content and method that stimulates and demands pupil activity, and an inherent method of thinking through and attacking everyday life problems that promises to equip children for intelligent, useful and happy living.

Religious Values of Nature Study

In the Primary Grades

• By Sister M. Marcia, O.S.B.
ST. BENEDICT ACADEMY, ERIE, PENNA.

To teach the child that God is in and through all things, that all nature works with infinite patience to fulfill the divine purposes, and that God dwells within the humblest part of nature's life—these are some of the purposes of nature study in the Catholic elementary schools. They should be a part of the secondary school program, too, for through the study of nature the will is motivated to serve the One Who has created all things.

The Editor recommends this article to every teacher of science.

●

"God made us to know, to love, and to serve Him."

The importance of this early-paged catechism truth is especially evident to educators. Every primary teacher knows that young children crave stories about our Lord's life. They are thrilled by heroic tales and fascinated by highly colored pictures. Instructors have realized for some time that the absence of these features makes the traditional catechism dull.

Christ, the Great Teacher, taught love and mercy as the keynotes of human conduct; and there is ample evidence that the benefits of these qualities were to be extended to all creatures that are our fellow-tenants on the earth we presume to call our own, but on which, with them, we are transient guests. Herein is living help of the greatest practical value in education.

Teachers of religion, then, devote their best efforts to the catechism lesson, supplying the craved stories and the colorful pictures; but utilizing even more effectively another revelation of God second only to that found in His church.

I refer to the Creator's speaking to His rational creatures through the natural wonders of His universe.

If we admit that God does so reveal Himself, we are forced to recognize the moral and religious values of Nature Study. Although some educators have carried the idea to the extreme of faddism, the fundamental truth remains, that in leading the soul to God, nature is religion's faithful ally.

To draw the little soul to the Great Teacher, the child must be led by one who herself has learned to look with answering love up to the divine love of which nature ever speaks. The mere fact that one is surrounded by charming scenery is not enough; for nature, unaided, does not tell her message to the beholder. To truly learn her rich lessons, the inner eye of the spirit must be trained to see in the marvel of the dawn and the splendor of the sunset, the greatness of the Almighty, to feel the mystery of life in the first faint flush of the blossoming trees, to hear the voice of God as He calls forth the tender green grasses to cover the brown hilltops, to worship His power in the majesty of the storm, and to join in the beautiful chorus of His praise which the shining stars ever sing in their ceaseless whirl through space.

The study of the thoughts of God in nature, filling the mind as it must with beauty, prepares the imagination for clear and strong conceptions of the spiritual life. A child's mind filled with purity and goodness has no room for wickedness and sin.

The purpose of Nature Study in our Catholic educational system is to introduce, in a general way, the subjects of the lessons that will progress with life itself and will be fully understood and appreciated only in the light of eternity. I shall endeavor to give a brief exposition of the method of procedure.

The clouds are a part of nature which all children, those of city as well as country, will have seen and watched. They are used in the first lesson to begin the implanting of that truth which will run through the whole year's work; namely, that all nature is working together to fulfill the divine purposes and that God dwells within the humblest part of nature's life. I might mention here that the child should be encouraged to speak in his own way of whatever in nature seems beautiful and wonderful to him; however, his attention should be converged upon one particular subject at a given time.

In telling the lesson story of the clouds, the teacher awakens the interest of the child by appealing to his imagination. The story is told so vividly that a picture is presented to the mind or, perhaps, one recalled to the memory.

The teacher endeavors, from the beginning, to dwell upon the fact that it is God's loving care for the world that sends the clouds and eventually the rain—that God is in and through all things.

Early in life the child has, no doubt, been taught God's love and care for him and for all mankind in general; but as for God's being the prime factor in plants, trees, and grass—here is 'God's great plenty" at the free disposal of the instructor.

After the next lesson on the earth's garment of green, the child is impressed by the infinite patience with which nature obeys God's law, working over and over to cover with vegetation earth and rocks left desolate by storm and flood or laid bare by the toil of man's hands.

The child heart throbs to the suggestion,—"Consider the lilies of the field how they grow,"—then the little one is made to realize that God's laws are so wonderful

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You Should Read . . .

Getting Acquainted With Minerals

● *By* G. L. ENGLISH, Consulting Mineralogist, New York; McGraw-Hill Book Company, Inc., 1936. 324 pp. Photographs and Charts. $2.50.

This book gives to the reader more than its author promises in the preface. While it is scientific and technical, it is also remarkably interesting. In its study of minerals it touches upon physics, including optics, chemistry, geology, and crystallography, but little previous scientific knowledge on the part of the reader is assumed. The author presents such facts and theories of these sciences as he deems essential to the understanding of the topics treated.

The book is clearly written, and contains numerous excellent illustrations. It is divided into three parts: 1. About minerals in general. 2. Description of minerals. 3. Description of rocks. The appendix contains tests for the identification of minerals, and a pronouncing vocabulary.

This book will make a good addition to the high school library. *J. F. M.*

The High School Science Teacher and His Work

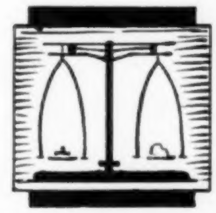
● *By* CARELTON E. PRESTON, Ph.D., Associate Professor of the Teaching of Science, University of North Carolina. New York; McGraw-Hill Book Company, Inc., 1936. xvii + 272. $2.00.

This book was written to aid students who are preparing to become teachers of science. It will be helpful, too, to science teachers in service.

Dr. Preston discusses the evolution of science courses and science teaching, considers various teaching methods, tells how to evaluate a textbook, and gives hints about teaching pupils how to study. His views on class demonstrations, laboratory work, notebooks, and drawings, are interesting and valuable. Tests and testing, excursions and field trips, and visual education are treated in separate chapters.

This book is not intended to be encyclopedic. It doesn't contain everything a good teacher should know about teaching science. It could not; but it does contain more than most teachers know about it. It doesn't burden the young reader with an abundance of details nor discourage him with many solemn warnings. It is planned to encourage and inspire; it will not bewilder.

Dr. Preston's book is written in a pleasant style. We like it for its friendly tone, and for its restraint, and its sound advice. No book can make a fine teacher out of poor material, but this book should make of every teacher and prospective teacher who studies it intelligently, a better and more thoughtful instructor and one who will have a clearer understanding of the job he is expected to do. *H. C. M.*



General Science for Today

● *By* RALPH K. WATKINS, Ph.D., Professor of Education, University of Missouri, and RALPH C. BEDELL, Ph.D., Professor of Education, State Teachers College, Kirksville, Missouri. New York; The Macmillan Company, 1936. x + 715. Illustrated. $1.72.

The material contained in this revised edition is divided into fifteen units, each consisting of two or three chapters. The units are selected and arranged so as to present an uninterrupted and continuous story, a feature not always to be found in a textbook of this kind. The story begins with an examination of man's environment. This leads into a study of earth materials and natural forces. Then man's attempts to control the forces of nature are investigated.

This book is well written. The balance maintained between the physical and biological sciences is indicated by the number of pages devoted to each. According to the publishers, the separate sciences occupy the following number of pages: physics, 231; biology, 133; hygiene, 90; geology, 43; chemistry, 30; astronomy, 28; weather and climate, 21.

A valuable feature of the book is a unit dealing with the development of the scientific attitude. Its analysis and discussion of the method of scientific investigation should encourage the student to think more independently and to be curious about scientific things. A final chapter gives a list of agencies from which reliable scientific information can be obtained.

Durable binding, a good selection of type faces, and abundant and well chosen illustrations make an attractive book. A better grade of paper might have been used to advantage.

Teachers who plan a change of texts, should give consideration to this practical book. *H. C. M.*

Individual Study Projects

Continued from Page Thirteen

schedule of the school. To take a whole group out of the school for several hours seriously interferes with the normal running of the average system and in many cases works an undue hardship on the other teachers. Further, while it is important that the occasional monotonous routine be broken by some such procedure as a field trip, it obviously should not be a practice that the students will look on as a mere picnic.

Now let us see where the individual project comes into this picture. Our conclusions from the above discussion seem to be that while class field trips are essential to a living course in biology they should be used sparingly. If that is true, then it becomes necessary to supplement the field trip with something that will give an opportunity for students who are especially interested, to carry out a more detailed study of the objects of their interest. That is where the instructor can advise and encourage the working out of projects. These projects will give the student a more definite acquaintance with nature and the things of nature. Work "on his own" and with something that interests him will help the worker to feel his own importance and will in turn stimulate him to further effort until his leisure time is completely taken up. The working out of one project may lead to the beginning of another and that, incidentally, to a broadening of interests such as is necessary to the awakening of young people to a realization of their place in the world and in life. If the development of some particular interest does nothing more than lead to the following of an absorbing hobby that serves to keep a potential or even former "street-corner-loafer" from an eventual conflict with society and the law, it will have been highly successful.

On the other hand, not only will these projects be beneficial to the individuals concerned but they will also be valuable to the teacher and to the school itself in many instances. A nature museum is undoubtedly a valuable asset to any school system. Such a museum can readily be made the outcome of a carefully planned series of individual projects. Such a plan would need to have a modest beginning, and aim toward a gradual enlargement. The procedure followed in building up such a year-after-year project must be one involving the cooperation of the teacher and the students and not an arbitrary demand on the part of the teacher. It will, no doubt, frequently happen that students will feel highly honored to have their piece of work selected for a permanent place in the school museum. On the other hand, if they are encouraged to collect or prepare two of each object represented in the finished product of their labors then it will be possible for them to keep one and to present the other to the school. Whatever else is done in respect to this progressive plan of acquiring a museum, a great deal of care should be used in culling the prospective exhibits. Only those things which have a definite instructive value and are particularly well done should be selected for a permanent place. These museum exhibits, if properly selected, should form a group of invaluable demonstration materials. In this manner the teacher can gather together numerous visual aids to the teaching of his course.

An obvious handicap to such an ambitious plan is the housing of the selected exhibits. Where can I keep these things when I do have them? This problem must be solved by each teacher alone while keeping in mind his own local set-up. Most administrators will be glad to cooperate to the limit of their ability to find suitable exhibition cases in which to properly display such valuable and profitably acquired exhibits. In any case, the teacher's first problem is to get the exhibits. After that, he must carefully pick and choose until he has the best, in so far as his own needs are concerned. Finally, when he knows what he has to exhibit and has a clear idea of what he wants in the near future, he can better plan for the housing facilities. It is certainly better to have the demonstration material and not have a proper place in which to keep it, than not to have the material at all.

In the mind of the writer, the most important thing about the planning and working out of individual projects in the study of biology is not their value as discussed above, but rather the carrying out of "student-selected" activities. It is, of course, the place of the teacher to suggest, guide, and encourage such activities but he should never force the student to do a project. If force is necessary in order that the plan be carried out, then it had far better be dropped and something else tried, for nothing will serve to embitter the student against the study of nature more than the use of force and coercion. After all, the modern teacher is a leader and not a slave driver. Encouragement and direction of natural interests by a sincere and enthusiastic instructor play a big part in developing a keen and enthusiastic class.

It may be that certain rare classes will have in them individuals who will carry out projects from the very beginning of their biological careers without having any prospect of material reward for this extra effort. It has been the experience of the writer, though, that these beginners must be rewarded in some manner for special efforts. Whatever plan of awards is adopted, it should be such as to give the beginner a reason for doing special work. Once he becomes interested in that sort of thing, then the material rewards, whatever they are, need not be continued. Each teacher will no doubt have a system of his own by means of which extra credit or some such reward can be given for extra work of good quality. One such system that has been tried out by the writer and has proved successful was recently reported[1]. The biologigy club offers an opportunity for the interested beginners to continue their independent investigations under the guidance of the teacher. In

[1]Crummy, Pressley L.—Biology in the Secondary School — *School Science and Mathematics*—XXXVI (8):854-858. November, 1936.

these cases, interest that has been aroused previously will serve as its own stimulus to further study.

Let us consider briefly a plan for beginning this system of individual projects. In the first place, the biology course will be started off in the fall as is any other course, using a textbook that is suitable. Then, very soon after the beginning of the school year, perhaps during the second week or even at the end of the first week, a class field trip should be planned if possible. This first trip will have as its aim that of exploration. The teacher must know the ground to be covered and plan to point out certain interesting objects. The students should be warned before starting on the trip that they will be expected to give either an oral or a written report of their findings. It is often advisable to plan brief oral quizzes for this trip. Subsequent to this exploratory journey and even during it,the instructor must be on the alert to detect any evidence of interest by various students in certain particular things. He can then explain to the class how they can benefit by working on something that interests them especially. Whether any of the class show interest in attempting a project or not, no further class field trip should be taken for a couple of weeks. The next trip and all subsequent ones should have some specific purpose such as identification of trees, bird study, methods of seed dispersal, and so on. Each of these carefully planned excursions into nature's laboratory should be followed by an examination over the things encountered along the way, to say nothing of frequent discussions and quizzes while in the field. In the meantime, it is almost certain that several members of the class will have become interested in some phase of the work and will be starting a project. The teacher will be busy advising and encouraging these people in their efforts. Once work on a project has started, however, the individuals concerned will need less of the teacher's time. In those cases where it is next to impossible to have class field trips, one can usually manage to find a few students who can be persuaded to collect some natural objects outside of the school hours and to bring them in to the class. In this way it is possible to start a few students on individual work. Later, others will want to do the same thing, and soon many will be involved in doing one or another kind of individual project.

There is literally no end to the kinds of projects that might be worked on in a biology class. Fortunately there is considerable source material available from which both the teacher and the student may secure detailed instructions for carrying on the various projects. A brief list of some of these sources of information has been appended to this article for convenience. Any teacher can sit down and make up a long list of workable projects but it is often inconvenient to do so. Accordingly, a list of suggested projects has been incorporated in this discussion. Some of them will involve the student in considerable effort, others will prove less difficult nad should, consequently, bring a smaller reward for their completion. Since these projects are designed to occupy the individual student who is interested in them, the teacher should demand a high quality of work and not be satisfied with slovenly attempts. At the same time he must encourage the student and commend him for good work when it is performed.

Suggested Projects

- Leaf collections
- Leaf prints
- Mushroom spore prints
- Plaster casts of leaves
- Pressed flower collections
- Weed collections
- Collections of tree bark
- Collections of mushrooms
- Making microscope slides of small organisms
- Making lantern slides
- Balanced aquaria
- Bog terraria
- Desert terraria
- Preparing study skins of small mammals
- Identification of birds in the field
- Bird photography
- Caring for the laboratory Zoo.
- Study of life in a measured plot of ground
- Study of life in a nearby freshwater stream or pond
- Preparation of demonstration dissections
- Making life cycle diagrams
- Study of the amphibians of vicinity
- Study of reptiles of vicinity
- Field identification of all trees in the vicinity
- Making colored drawings of birds
- Marine aquaria
- Supplying the class with seedlings
- Culturing molds and bacteria
- Testing antiseptics
- Planting and caring for shrubbery
- Collecting and studying ant colonies
- Study of bee culture
- Study of embryonic development of the chicken
- Collections of ferns
- Collections of seeds
- Collections of fruits
- Making a nature calendar
- Preparing skeletons of small mammals
- Making a bird calendar
- Making a museum collection of different species of snakes
- Making plaster casts of tracks
- Taxidermy of small animals
- Stalking and observing habits of some animal
- Making insect collections
- Insect photography
- Culturing maggots of the housefly
- Making a nature trail
- Making a spider web collection
- Collecting spiders
- Fermentation experiments with yeast and different sugars
- Maintaining the biology bulletin board

Suggested Sources of Information

Macmillan Company, New York City, New York.
Williams, S. H.—*The Living World* (published in 1936.)
House, H. D.—*Wild Flowers* (Well illustrated, very good.) (Imperial edition—\$3.95)
Ditmars, R. L.—*Reptiles of the World* (very good.) (Imperial edition—\$1.89)
Wright, M. D.—*Birdcraft* (Illustrated by Louis Agassiz Fuertes.) (Imperial edition—\$0.89)

G. P. Putnams' Sons, New York City. *Field Books.* Write.

General Biological Supply House, 761-763 East Sixty-ninth Place, Chicago, Illinois.
Many useful publications are free to teachers. Especially good in this connection are: Catalog and Teacher's Manual No. 6.
Turtox Service Leaflets (Set of 48 free to teachers)—Number 19 especially good in this connection.

The American Tree Association, 1214 Sixteenth St., Washington, D. C. *Forest Primer.* Write for information.

Wild Flower Preservation Society, 3740 Oliver St., N. W., Washington, D. C.
Taylor, Horace—*Wild Flower Names of Northeastern States.* (\$ .50.)

Whitman Publishing Company, Racine, Wisconsin. (Also usually available in local branches of Woolworth's 5c and 10c Stores.)
Ashbrook, F. G.—*Red, Blue, and Green Books of Birds of America* (10c each.)
Harvey and Lawson—*Wild Flowers of America* (10c.)
Fazzini, L. D.—*Butterflies of America* (10c.)

Comstock Publishing Company, Ithaca, New York.
Comstock—*Handbook of Nature Study* (very good.) Write for price list and catalog.

National Recreation Association, 315 Fourth Avenue, New York, N. Y. Write for list of publications dealing with nature study.

Ward's Natural Science Establishment, Inc., P. O. Box 24, Beechwood Station, Rochester, New York.
Klots, Alexander B.—Directions for collecting and preserving insects (15c.) Other publications are available. Write for list

The Museum - Class Room

Continued from Page Twelve

in the museum but an equal quantity is purchased. It cost nearly $300 to complete a Pompeian house model, an equal amount for the costumes of certain south-eastern European countries, and a considerable sum to acquire types of medieval armor. The taxidermy shop is busy, and the model making room has a long and heavy task to supply working models of ships and machinery, but the task is performed and the object produced.

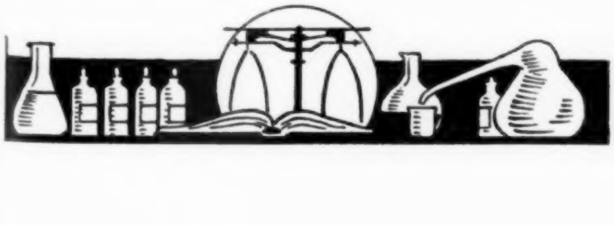
One of the new projects in Rochester is the creation of a mathematical museum with a lending division. This will include models of geometrical forms, mathematical tables and charts, and apparatus of various kinds used for precision work.

A frequent question asked is whether or not this valuable material is not abused or broken. Some ask if much of it is not lost. It is true that fragile things are sometimes broken, due to imperfect packing or to careless handling, but not one collection in 37,000 loans has been lost. This is due as much to the careful record keeping as it is to the interest that teachers and pupils take in this service.

Pedagogically, teaching by means of objects and experiments is sound. It is highly effective also since it makes realities emerge from what might have been only words. Contact with reality builds clear concepts and judgments. This is so far true that our museum has known of a pupil, absent for an entire project period due to illness, to pass at the top of the class in one exposure to a presentation within the museum, for the museum does have its own "demonstrating" program.

This loan service is capable of much greater development, for its limitation is only that set by staff and funds. Indeed, a county or a state might develop its own lending service and ship exhibits to schools over a wide area. In Rochester the service is restricted to the boundaries of the municipality, since the work is supported by the city. It would seem that the state museums of the country might adopt this plan and thus directly serve a larger portion of the population.

Out of this museum service has grown a plan for conducted tours in the several fields of nature and to industrial plants. All this brings the museum into the fore as an educational institution. Indeed, it has been said that in the modern sense "the museum is the latest development in the field of creative education." If this is true it is because the museum is now interested in people. The modern museum, therefore, declares that it is not what the museum has, but what it does with what it has, that counts.



Religious Values

Continued from Page Twenty

that any one of His creations in living according to His laws not only lives its own life well but helps some other form of life. The child learns that the big, noisy bees going in and out of flowers gathering the pollen and the nectar are helping the flowers as well as themselves; that their soft, furry bodies brush off and catch grains of pollen when they visit one flower, and leave other little grains upon the waiting pistil of the next. The bees always visit the same kind of flowers each day, and the flowers are so formed as to assist the bees in getting and carrying the pollen. The child will see that in accordance with God's plans, the flowers and bees are really good friends. They work together not only for their own good but also for the good of the world. Obviously, the application is that since God so watches over the flowers and has the bees help Him, will He not watch over His children with even more loving care?

When the child memorizes the lines—"But only God can make a tree,"—he can be led to ask—"How does it happen that every leaf among the thousands on a tree has its own place and grows, unhampered, by its neighbor leaves?" And he is made to see that it does not happen. It is all planned and arranged to be so. He learns that it does not just happen that our hands can reach our mouth, or that we can digest the food we eat. That was God's plan for mankind. The leaves of every tree are little kitchens where the water and the mineral salts it contains are prepared for the use of the whole tree. The sun furnishes the heat. Each leaf must hang free and have its own place where it can receive the life-giving sunshine and breathe in the air. Every tree is looked out for, and most carefully, so that it can provide for its leaves. The application follows: —The light of God's presence is to us what the sunlight is to the tree. It is that light shining into our souls which makes us grow to be true children of God.

The child dwells on the thought:—"The birds of the air have their nests and foxes their holes, but the Son of God has not whereupon to lay His Head." He loves to remember that St. Francis of Assisi used to call the birds his little brothers and sisters. Let the child know that it is just at the time when they are building their nests and having their busy life together with their little ones that the birds sing. It seems as though they mean to thank their Maker for this beautiful world and for the joy of being together and of serving the little helpless birdlings they work so hard to feed. Their sweet music is one of God's gifts to man—a gift of joy and delight, for which, with the other wonderful things in the world, our hearts give thanks. These dear little servants of God show us, who are His servants also, how to keep a heart of joy while we do our tasks. The words of Isaiah are understood,—"Behold, my servants shall sing for joy of heart."

The love for animals is one of the greatest gifts that can come to us in babyhood. As little children we turned to the dog with the same trust and affection that we gave to brother and sister. The child discovers that the life of a faithful dog is bound up with his master's, that he loves his master with such true devotion that his master's wishes are his first desire. Would it not be worth while to try to be as faithful a little friend to those we love as the dog is, and as obedient to authority?

It necessarily follows that the little heart thus led to contemplate the beauties of creation feels that God is a real Person. He is not, however, some one who is to be feared. He is a kind and loving Father—He is the Divine Friend of children. The hearts of the little ones are truly responsive to the love of Christ, for they know but little of the power of the passions rebelling against the spirit of Divine Love. Each child is beautiful in the garden of God, and each child possesses a beauty peculiar to himself.

The child, through nature study, is brought to the realization that it is the Infinite Love of Christ that watches over our every act—that preserves our being every instant. We have come from GOD—we are creatures of God—we are creatures of LOVE.

Surely there is plenty of opportunity in nature study for the primary teacher to introduce many of the fundamental truths of our holy religion. Only those truths which children accept lovingly—those that enter naturally into their minds and hearts, are converted into action which will influence lives for time and eternity. Every doctrine suggested to the little child must be presented as a mark of God's love. Since love begets love, the child will want to love God in return, and he will ask,—"What can I do for God, since He is so very good to me?"

The religious information we place in the little soul must grow from within, if it is not to die off leaving behind only a dead seed where once it attempted to grow. We defeat our purpose when we fail to show the child that this God, Who has created all things for our pleasure, dwells among us.—"I am come that they may have life, and may have it more abundantly." To make the life of our dear Lord enter largely into preparation for First Holy Communion seems the most natural way of drawing the hearts of the young to Him. It would, indeed, be sad to think of children approaching the altar-rails knowing little or nothing of His life and His love for us beyond such facts as the little catechism teaches.

While the child must learn certain dogmatic truths, this knowledge does not satisfy the desire of the little heart to know God more intimately. It is through the interpretation of Nature Study that the child's will is motivated to serve the One Who has created all things.

Assuredly, we teachers shall find our reward in the fulfillment of the glorious prophecy which makes mention only of work and speaks not of failure or success—

"They that shall instruct many unto justice
Shall shine as stars for all eternity."

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Laboratory Drawings

Continued from Page Eleven

construction of seven laboratory drawings. In the case of the experimental group these drawings were not made by the students, but prepared drawings to be labeled were supplied instead. The control group made the drawings as usual. Other conditions were kept uniform for both groups. The same objective tests were administered to both groups. A shorter test was given several weeks later in order to measure retention.

The general conclusions were as follows:

(1) The procedure of labeling prepared drawings and the procedure of making original drawings are equally effective with regard to the student's ability to acquire and remember factual information from his laboratory observations.

(2) The two methods are equally effective at all levels of student ability.

(3) It requires less time to make observations and label prepared drawings than it does to observe and make original drawings.

(4) The prepared drawing procedure is more economical of time and hence more effective. It requires less time to be spent in drawing and allows more time for observation and other laboratory activities. It is presumed that this time saved may be used to develop the more valuable outcomes of laboratory work.

(5) It is suggested that the prepared drawing replace the student drawing especially where the drawing is too difficult or is of the representative type.

A similar study by Taylor[10] yielded similar results. Although she found a "consistent increase in achievement for those who did not make drawings" in an elementary course in plant biology, the writer's study has shown that prepared drawings are just as effective as student drawings in connection with animal biology.

It would seem from these two studies that the prepared drawing has considerable pedagogical value and might be incorporated with profit into the teaching method in elementary courses in biology.

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Science Project Work

Continued from Page Five

pupils who have not yet reached a certain age. In overcrowded schools, with overlapping sessions, the laboratories or workrooms often are not available for club work. In some instances, the cooperation of the laboratory assistant in supervising individual pupils or small groups, while carrying on his own work in the laboratory, helps to relieve this situation.

One may well ask what the sponsor may do to make the best of the possibilities. Getting a new group under way can be facilitated by means of a common project. The ten-cent knock-down motor, and the Eastman knock-down pinhole camera have served very well in this need. Organized projects in individual cupboards or drawers, as proposed by Dr. Morris Meister, meet the situation very effectively. According to Meister's plan, each cupboard contains the necessary material, together with printed directions, for a particular project.

Since group projects offer means for valuable training in cooperation and other desirable social traits, the sponsor should encourage them. Incidentally, he will be relieved of the need for directing a large number of projects. By cooperating with each other, the students sometimes will be less inclined to call upon the sponsor for aid. He may, however, have to arbitrate disagreements.

An everpresent problem is the need for directions and working plans. The exceptionally bright pupil with some experience in the particular field of activity will as a rule require less detailed directions. After having decided upon a definite project, the pupil should collaborate with the sponsor in outlining the method of procedure. The type of outline, and the manner of drawing it up, will be determined by the nature of the project and all the other circumstances involved. Informal conferences may be held from time to time, during which suggestions will be offered by the sponsor. Even where detailed directions are supplied, the assistance of the sponsor will be required. Popular science magazines and science books feature project suggestions. Frequently, projects call for the use of certain tools or other equipment not available to the club. Such difficulties may sometimes be overcome by the exercise of ingenuity on the part of both the sponsor and the pupil.

The writer, who has had difficulty in locating published directions for suitable projects, has worked out a procedure that has proven successful. Projects of his own design, or suitable modifications of those proposed by others, were carefully written up with detailed directions. Blue prints of the drawings were included, and the whole set bound in an oak tag cover. These sets have proven particularly valuable to inexperienced students as well as to older, more expert ones. They learned to follow printed directions, and to do their work in systematic fashion. They were confident that success would be the reward for careful workmanship. When the project was properly suited to the interests and needs of the individual pupil, he profited much. As far as possible, the pupil should be made to feel that the choice of a project rests with him.

Youngsters like to have their projects placed on exhibition. A semi-annual or annual exhibit offers an incentive for doing good work. Some schools hold such exhibits. The American Institute of New York holds an Annual Science Fair. Many prizes are awarded among hundreds of elementary and high school entries. This annual fair has had a definite and beneficial effect on science project work in New York City.

In conclusion, it may be pointed out that certain practical conditions determine the extent to which construction projects may be carried out by high school students. These conditions may even render such work almost impossible of realization. However, an ideal set-up should be the goal. Good equipment is necessary, and careful planning is essential to success. The sponsor, too, must be ready to devote considerable time to the activity.

The Pontifical Academy

Continued from Page Fourteen

selves to the study of experimental sciences and who have changed their attitude and their intellectual course in regard to religion.

"It is unfortunately true that, in times not so long gone, some learned men, for reasons other than love of truth, have abandoned, as prodigal sons, the paternal roof of religion. Especially during the past century there were those who thought with false and rash arguments that the findings of human science were in open contradiction to the teachings of Divine Revelation.

"It is, however, a source of profound joy to our heart that in our day these prejudices are so evidently outmoded that there are now few, who have really studied the positive sciences and who continue to sustain this error. On the contrary, in the course of Our Pontificate many scientists, among whom were men of the highest worth and standing have come to Rome from distant lands in order to participate in scientific congresses and have come into Our presence to express their devotion to Us, or, later, to the Authority which lives forever in the Apostolic See, even though exercised by an unworthy successor of St. Peter. It has happened at times that among those there were some who, though not possessing the gift of Catholic Faith, believed it their duty to pay their respects to Our See which is the chair of truth. There were those who, speaking in their own names, and in the names of their colleagues, did not hesitate to say that true science leads, prepares, and directs souls to the Faith."

The members of the *Accademia dei Nuovi Lincei*, which now becomes the Pontifical Academy of Sciences, retain their titles as honorary, ordinary, or corresponding members and, in the institute, enjoy the wide privileges in conformity with the statute as promulgated. They will continue to be members of the categories to which they belong, unless they are elevated to the rank of academicians. Successive academicians are to be selected by the members themselves and confirmed by the Holy Father. Father Augustine Gemelli, O.F.M., an alumnus of Saint Bonaventure College, has been named by His Holiness as the new president, and has been extended the Papal Benediction for himself, the Pontifical Academy of Sciences, and all its members.

Again does the Church, through her Supreme Ruler, foster the pursuit of learning in stating the purpose of this new Scientific Senate of the Church. Its members are expected to honor their names as Pontifical Academicians by austere and noble work in the field of knowledge and, in this way, to render religious homage of reason to the SUPREME TRUTH, the Creator.

Father Nieuwland

Continued from Page Fifteen

to a velocity of motion has been the backbone of the expanding universe theory often associated with the name of Abbé G. Lemaitre, noted Belgian scientist-priest.

Prof. Haas has calculated the amount of energy which matter can create in a unit volume of the universe and finds it far too little to overcome the gravitational attraction that must be overcome if the different parts of the known universe are rushing away from one another in a super-expansion. Prof. Haas supplemented his negative argument with calculations showing the amount of energy per gram of matter which would be required to double the mutual distances between nebulae in a system of mutual density.

The synthetic chemist's task of making big molecules out of little ones, which was the aspect of chemistry that held Father Nieuwland's own professional attention for many years, was discussed by Prof. Taylor. In building up these giant molecules, to make such things as artificial rubber, the proportion of the elements in the compounds may not change during the process, but the arrangement of their atoms does change radically, and this rearrangement of the building-blocks largely determines the properties the new substance will have, Prof. Taylor said. He told of the use of X-rays, ultra-centrifuges, and other modern tools of science to learn the arrangement and dimensions of these important but submicroscopic structural details.

Prof. Victorin prefaced his discourse on "Vanishing Floras of Northeastern America" wi.h a few pertinent remarks on the problems and philosophy of modern Catholic university education:

"The world is changing very rapidly. The young men and the young women of today do not, and cannot, think as we used to do, my dear colleagues above fifty! They feel more than we did in the happy old days, the great anguish of Littré the philosopher, 'devant cet Océan sans rivage, pour lequel nous n'avons ni barque ni voile'; the torment of Leonardo before the enigma of Nature and the enigma of Christ; the trouble of Pascal before the mystery of the world profiled on the mystery of God.

"Facing these terrible issues, two methods, two attitudes, two kinds of men: the man of cold science, and the mystic! Francis Bacon and Francis of Assisi.

"Our modern souls are parted, are torn by the apparent incompatibility of these two tendencies, these two violent calls for the absolute and the infinite. The modern souls, masters of tomorrow, need enlightened spiritual guides that will not tramp upon what is best in them, souls of such a quality that the spirit of Francis Bacon and the spirit of Francis of Assisi can cohabit and bring forth these new men, that have to be very different from us, if the world is to be saved through spiritual agencies. These new men and women, needless to say, it is the duty of the Catholic universities to produce."

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